

VOLUME-II
SECTION 6A
GENERAL SPECIFICATIONS

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A100 SUMMARY

A101 GENERAL

A101.1 Application

A101.1.1 The Specifications shall apply to all Works as are required to be executed under the Contract or otherwise directed by the Employer.

A101.1.2 The Specifications must be read in conjunction with the Conditions of Contract, Bills of Quantities, Drawings and other documents forming the Contract documents. Notwithstanding the subdivision of the Specification under different headings, every part of it shall be deemed supplementary to and complementary of every other part. The heading in these Specifications shall not be deemed to be part thereof or be taken into consideration in the interpretation or construction thereof, or of the Contract.

A101.2 Abbreviations and Acronyms

A101.2.1 The following abbreviations shall have the meaning as set forth below:

ASTM	American Society for Testing and Materials
BS	British Standard published by British Standards Institution
CD	Chart Datum for the Cochin Port Trust
CEMP	Construction Environmental Management Plan
CWMS	Construction Work Method Statement
COPT	COCHIN PORT TRUST
EMP	Environmental Management Plan
HAT	Highest Astronomical Tide
HAZID	Hazard Identification
SHE	Safety, Health and Environment
IS	Indian Standard published by the Bureau of Indian Standards
ISO	International Standards Organization
ITP	Inspection and Test Plan
LAT	Lowest Astronomical Tide
NCR	Non-Conformance Report
TPR	Third Party Review
PQP	Project Quality Plan
QA	Quality Assurance
QC	Quality Control
RL	Reduced Level
PIMT	Project Implementation and Monitoring Team

PMP	Project Management Plan
CPCB	Central Pollution Control Board
KSPCB	Kerala State Pollution Control Board

A101.2.2 The Contractor shall use the above abbreviations and nomenclature on its documentation.

A101.3 Definitions

A101.3.1 Words including Contract, Contractor, Employer, Drawings, Employer, Government, Works and Site used in this Specification shall be considered to have the meaning as understood from the definitions of these terms given in the Conditions of Contract.

A101.4 Reference Standards

A101.4.1 The Work covered by this Specification shall comply with the latest editions and revision notes of Indian, British and other recognized International Standards as may be specified elsewhere in the Contract Documents.

A101.4.2 The latest edition of all Standards till 30 (thirty) days before the final date of submission of the tender, shall be adopted. The Contractor shall maintain a copy of the latest editions of the Standards, Laws and Codes applicable to the work to be undertaken on site.

A101.4.3 The Contract Documents reference to a number of codes, standards and guidelines. In some cases, these documents may be in disagreement or conflict. Where conflicts or omissions are identified, the Contractor shall notify the Employer who shall make a determination and advise the Contractor accordingly. The Employer's determination will generally adopt the most conservative or stringent requirement.

A101.5 Working Drawings

A101.5.1 Two hard copies of the Working Drawings (Good for Construction), on the basis of which actual execution of the Works is to proceed along with soft copy in dwg format, shall be furnished free of cost by the Contractor.

A101.5.2 The Drawings provided for tendering purposes in the Tender Documents shall be used as a reference only. For Tender Drawings refer Volume-2 Section -7C.

A102 WORK COVERED UNDER CONTRACT

A102.1.1 The Works under this Contract are design, supply, installation and commissioning of Main Jetty, FIC Bay and Approach Trestle alongwith other services and utilities. The details are covered in Section-7A (Scope of Works) of the Contract Documents.

A103 SITE LOCATION

A103.1.1 The site location for the Works are as shown on the drawing provided in Section 7C of Volume 2. The Contractor shall submit details of any temporary works associated with the Works.

- A103.1.2 The Contractor's local office, his own working area and all of the Contractors Works shall be subject to compliance with CoPT established guidelines and applicable local authorities rules and regulations.
- A103.2 Permissions and Permits
- A103.2.1 The Contractor shall at all times comply with the latest requirements of:
- (a) Navigation, Shipping and Kerala Inland Vessel (KIV) Rules;
 - (b) Port Authority Acts;
 - (c) Marine Oil Pollution Management Plan;
 - (d) Marine Oil Pollution Contingency Plan;
 - (e) Emergency Response Plan;
 - (f) Cyclone Contingency Plan;
 - (g) State and National Environment Regulations.
- A103.2.2 The Contractor shall ensure that all plans and procedures developed in accordance with the requirements of the Contract are integrated with those of the Port /Naval operations at Cochin Port Trust/ Indian Navy/ Kerala inland Navigation rules.
- A103.2.3 The Contractor shall obtain advance approvals from the required authorities prior to executing the Works.
- A103.2.4 The Contractor shall make all arrangements with and obtain the necessary approvals from the Relevant Authorities for temporary marine traffic arrangements and control.
- A103.3 Existing and Temporary Aids to Navigation
- A103.3.1 The Contractor shall be responsible that existing aids to navigation are not damaged or otherwise made unserviceable as a result of any marine construction work or collision by any vessel. The cost of repair of any damage to existing aids to navigation, including replacement of the damaged aids, if necessary, which has occurred as a direct or indirect result of the Contractor's operations, shall be at the Contractor's cost.
- A103.3.2 The Contractor shall install and commission temporary structures, as directed by the Employer, to ensure the safety of the Contractor's marine plant and the continued safe operation of the navigation channel or waterfront.
- A103.3.3 All such Works are to be coordinated with the relevant authorities to minimise disruption to navigation channel/waterfront operations.
- A103.4 Marking of Landside Works
- A103.4.1 The Contractor shall exhibit such marks and keep illuminated during the darkness hours near the various parts of the Works as the relevant authorities or the Employer may from time to time require or approve.

A200 ADMINISTRATIVE REQUIREMENTS

A201 PROJECT MANAGEMENT AND COORDINATION

A201.1 Project Coordination Meetings for Interfacing Contracts

A201.1.1 The Contractor's Representative shall attend regular meetings as required by the Employer to coordinate and manage the interface between the Works under this Contract. The frequency of such meetings may vary depending on the nature of the interface and associated Works. However the Contractor should anticipate that meetings will be held at least fortnightly throughout the duration of the Contract.

A201.1.2 The Contractor shall be responsible for establishing and maintaining direct lines of communication, as coordinated with the Employer, with the relevant parties for the day to day coordination of his activities.

A201.2 Weekly Meetings

A201.2.1 The Contractor's Representative shall attend Weekly Meetings to be chaired by the Employer to discuss the progress of the Works and other relevant matters. The Weekly Meeting Agenda will typically include, but not be limited to:

- (a) Adoption of Previous Minutes.
- (b) Outstanding Matters.
- (c) Health and Safety.
- (d) Quality Assurance.
- (e) Interface Coordination with adjacent works.
- (f) Progress of the Works.
- (g) Programme Milestones, Achievements and Slips.
- (h) Resources (i.e. Plant and Equipment, etc.)
- (i) Survey and Clearance of the Works.
- (j) Contractual Matters.
- (k) Progress Payment Claims and Payments.
- (l) Environment Compliance Issues.
- (m) Other points, as necessary.

A201.2.2 When required by the Employer, separate meetings covering occupational health and safety; environmental management, quality etc. shall be held independently of the weekly meetings with the Contractor's specialist personnel in attendance and other Contractor's Safety Representatives also in attendance when, and if, deemed necessary, by the Employer or the Employer's Safety representative. Any unresolved issues arising from these supplementary meetings can be included and form part of the

weekly site meetings. Joint (Contractor and Employer) site quality walks and safety walks shall be carried out at regular intervals.

A201.2.3 Daily and informal routine discussions shall also be held each day, as/when necessary, between the Employer's and the Contractor's representatives.

A201.3 Contractor's Project Management Plan

A201.3.1 The Contractor shall submit, within forty five (45) days from the issue of Letter of Award, for the Employer's review and acceptance, a detailed Contractor's Project Management Plan (PMP) that provides specific details as to the execution process, methods and procedures which the Contractor will adopt for the Project.

A201.3.2 The PMP shall include methodology, policies, organization and resources to manage scope, change, schedule/programme, security, interface, budget and cost, quality, human resources, communication, risk, procurement, environment, labour management plan, taking over plan, workmen's accommodation/villages, etc. Detailed requirements for some of these plans are included in this specification.

A201.3.3 The PMP should reflect the holistic thinking process of the Contractor for the successful completion of Works from the commencement until completion

A201.4 Contractor's Project Organization and Staffing

A201.4.1 The Contractor shall employ on this Project, a competent team of managers, technical staff, etc. so as to complete the Works satisfactorily as per the various requirements of the Contract. The Contractor shall submit his proposed staffing plan and organization to the Employer for review and approval within forty five (45) days from the issue of Letter of Award, which shall include:

- (a) The Contractor's proposed Staff Organization in chart form showing the names of his proposed staff for each position;
- (b) CVs of the Contractor's proposed Key Staff with adequate details and copies of documentary proof for the individual's qualifications and experience (with contract titles, position(s) held) and dates to substantiate that he/she is competent for undertaking the proposed position;
- (c) The scope of responsibilities of each staff member and the reporting lines between individual staff;
- (d) The documents that each Key Personnel staff is authorized to sign on behalf of the Contractor.

A201.4.2 The Staff Organization shall cover the Contractor's Key Staff, as well as other working-level staff, with a narrative of the authorities and responsibilities of each staff member in execution of the Works, whether on site or in office locations, or in deciding technical details of the Contractor's submittals.

- A201.4.3 Each member in the Contractor's Staffing Proposal, including the Key Staff, shall be allocated to this Contract on a full-time basis on site until the activities that he is responsible for, have already been completed. Should it be necessary to replace Key Staff, before the activities he is responsible for have been completed, the Contractor shall submit the CV of the proposed substitute to obtain the Notice of No Objection from the Employer, at least 30 days before the proposed change. The substitute shall not be less qualified or experienced than the person he is replacing.
- A201.5 Project Controls Execution
- A201.5.1 The Contractor shall employ the appropriate level of suitably qualified and experienced personnel, having competencies in preparing integrated project programme, cost, resource allocation, and establishment of a baseline plan for monitoring and performance measurement.
- A201.5.2 The Contractor's Project Controls will be executed on the Employer's programmes through integration of the following:
- (a) Time Management;
 - (b) Cost Management;
 - (c) Resource Management;
 - (d) Change Management;
 - (e) Performance Measurement;
 - (f) Reporting.
- A201.5.3 The Contractor's Project Controls must include work breakdown structures, organizational breakdown structures, milestones, cost and programme information, risk, scope and deliverables in sufficient detail to allow a schedule baseline to be set at a level that facilitates visibility of performance and ease of reporting.
- A201.5.4 The Contractor shall develop the Contract Price into the budget baseline and define the resources (labour, plant/equipment, material, subcontract and overhead) required to deliver the Contract Scope at the lowest level of Work Breakdown Structure (WBS). Individual WBS elements are broken down to align with the integrated schedule activities and each activity is broken down and coded by cost elements.
- A201.5.5 The Contractor is required to ensure that schedule and execution risks are supported with mitigation measures. The Contractor shall establish and use quantifiable performance measurement tools and Key Performance Indicators (KPI) for each stage of the Contractor's Project Management process. KPIs are to be reported on a weekly and monthly basis in accordance with the Employer's requirement and must address all foreseeable contract risks and give early warning of Project performance.

A201.6 Contractors Emergency Contact Details

A201.6.1 Prior to commencement of construction Works, the Contractor shall provide to the Employer, and all other relevant government agencies, the 24 hour contact telephone number of two (02) persons with authority over the Works during the construction period. The persons shall have authority to take immediate action to shut down any activity, or to affect any emergency measures as directed by the Employer or any other relevant government agencies.

A202 WORK PROGRESS DOCUMENTATION

A202.1 Detailed Work Sequence and Methodology

A202.1.1 The Contractor shall be responsible for scheduling, actions, personnel, materials and all other aspects of the works (for design and construction) necessary to achieve completion of the whole of the Works within the approved programme/schedule and subject to the restrictions contained in this contract, including granting of Right of Access to the site areas and use as specified earlier.

A202.1.2 Along with the submission of the detailed programme/schedule (in accordance with Conditions of Contract), the Contractor shall submit to the Employer for approval, the detailed design and construction work sequence and Methodology (including mechanical equipment proposed to be used), sequence of various activities, key milestones (including priority works) and the overall programme from Contract start to completion of all works.

A202.1.3 The detailed Works Programme and Methodology shall be consistent with the overall sequencing of the Work Methodology submitted in the Contractor's Tender and shall provide additional details of the Contractor's proposed method of design and construction and sequence of work, with particular attention to priority works. The Works shall be planned such that proper site safety, drainage and free flow of traffic are maintained at all times. The Contractor's works sequence and scheduling shall conform with any additional construction sequence or phasing requirements and shall include due allowance for all inspection, testing and document review requirements nominated on the drawings and/or elsewhere in this specification.

A202.2 Contract Programme

A202.2.1 General

- (a) The required time for completion of the works is stated in the Appendix to Tender.
- (b) The Contractor shall submit a Detailed Time Programme (DTP) to the Employer for acceptance as required under this Contract.

- (c) All programmes submitted to the Employer (including: the 120 days Preliminary Programme; the DTP and including any subsequent updates or revisions to the aforementioned documents), must be prepared and maintained using Primavera P6 version 7.0. Evidence of the Contractor's Planner's ability in the use of P6 shall be required to be submitted prior to submittal of the programme.
- (d) The DTP prepared by the Contractor is to have a WBS based on information provided by the Employer. The logic and activity sequence of the DTP should also follow the Critical Path Method (CPM) standard. The WBS shall be used for design submissions, shop drawings, procurement, subcontractors, and construction, inspection, commissioning and Taking-Over operations.
- (e) The DTP shall identify submission dates of Work Method Statements (WMS), various interfaces and other key deliverables as identified in the specifications.
- (f) The Contractor shall allow for thirty (30) days review time by the Employer of all submittals within the DTP.
- (g) The DTP shall at all times accurately reflect the Contractor's current plan for the work and shall be the primary tool utilized by the Contractor to document the progress of the works and to communicate the timely completion of the Works.
- (h) The Contractor's monthly progress reports (Monthly Reports) and applications for Interim Payment Certificates must incorporate an updated DTP indicating work activities and status in accordance with the requirements of this specification.

120-day Preliminary Programme

- A202.2.2 The Contractor shall submit a 120-day Preliminary Programme within 20 calendar days from the issue of Letter of Award. The Preliminary Programme shall show in adequate detail, to the satisfaction of the Employer, all the activities that the Contractor will undertake during the first 120 days from the Commencement Date. The Contractor shall update and maintain the Preliminary Programme on a weekly basis. The Contractor shall extend the duration of the Preliminary Programme and maintain the weekly updates until the Contractor's DTP (Baseline) is accepted by the Employer.

Contractor's Detailed Time Programme (DTP)

- A202.2.3 The Contractor shall submit the detailed time programme to the Employer in accordance with the requirements of the Contract and subject to the additional requirements of this Specification.

- A202.2.4 The work programme shall be submitted in both A1 hard copy (six copies) and Primavera P6 version 7.0 electronic format or other form approved by the Employer. Electronic copy shall be either on CD-ROM or on DVD or via Project Management Information System (PMIS) as instructed by the Employer. Contractor shall supply, at his own cost, one copy of the licensed software used for making the work programme, capable of being run on two separate work stations, to the Employer in addition to the soft copy stated above.
- A202.2.5 The work programme shall be consistent with the overall sequencing of the programme submitted in the Contractor's Tender and shall provide additional details of the Contractor's proposed design timelines and method of construction and sequence of work including but not limited to the following:
- (a) All design phases with review time and re-submissions.
 - (b) All physical work to be undertaken in the performance of the Contract obligations, including Temporary Works.
 - (c) All major activities including design.
 - (d) The requested date for issue of any information by the Employer.
 - (e) Incorporation of principal aspects of design programme and design submission programme.
 - (f) Due time allowance for review by the Employer of the Contractor's submissions, as well as the subsequent amendment and re-submission by the Contractor in the design review and comment process.
 - (g) Time required for gaining any permits, permissions or approvals from government or statutory authorities as may be required under the Contract.
 - (h) Time required for the submission and approval of materials, procurement of critical materials and equipment, fabrication of special products/equipment etc.
 - (i) All activities of the Employer that are likely to affect the progress of the Works etc.
 - (j) Completion of priority works (Section I).
 - (k) The Contractor shall provide a manpower histogram, which shall be extracted or based on the cost/resource loaded programme.
 - (l) Off-site procurement and delivery activity durations shall not exceed 60 calendar days.
 - (m) Manufacturing, inspection and shipping activities shall be broken down into sufficient detail to allow adequate progress reporting.

- (n) Sufficient allowance shall be made for preparation, submission and review of submittals. Allowance shall be made for reworking and resubmitting major submittals that may not receive an "Accepted" status at the first submission.
- (o) All logical dependencies between the major activities.
- (p) The time and sequence required for executing the Works broken down into activities not exceeding one month.
- (q) Dependencies between items of work as normally identified in Critical Path Analysis methods in precedence GANTT form.
- (r) The minimum duration of each item of work.
- (s) All relevant time, site or other restraints including those imposed by the Tender Documents.
- (t) Milestones, including priority milestones, with their dates.
- (u) The sequence of activities that form the critical path for the completion of the Project.
- (v) The proposed human resources and plant for each item of work on the Critical Path.
- (w) Interface requirements and/or dependencies with Works to be accomplished by other adjacent contractors.
- (x) Any work to be subcontracted with the name of the subcontractor identified.
- (y) Points of interface between the Contractor and the Employer.
- (z) All contract milestones, including inspections, Taking-Over, and testing.
- (aa) Each separable portion of the Works if applicable.
- (bb) Total float on all activities and the Critical Path.
- (cc) Projected impacts due to severe weather including annual monsoon season.

A202.2.6 The Contractor shall submit a narrative report with the DTP (Baseline). The Contractor shall submit a proposed narrative format to the Employer for acceptance which shall include, as a minimum, the following:

- (a) Description of the Scope of the Works, including design and construction phases.
- (b) Detailed description of the Contractor's approach to design and construction, including the sequencing and the execution of the Works (including any Phasing or Staging as required by Contract).
- (c) Description of the Critical Path.

- (d) Any adjustments made to the Baseline since the issue of any previous issue of a DTP report, and the date of the associated Employer's confirmation of acceptance.
- (e) Potential or anticipated issues that may affect progress.
- (f) Lists of :
 - (i) Calendars used.
 - (ii) Lags used (only lags previously confirmed by the Employer can be included).
 - (iii) Constraints used (only constraints previously confirmed by the Employer can be included).
- (g) Graphs, histograms or lists indicating anticipated use of the following resources and work shifts:
 - (i) Labour resources (design and construction (by site)) break up by major competencies and/or trades.
 - (ii) Equipment resources (by site).
 - (iii) Principal Quantities (by site), (i.e. volume of excavation, volume of concrete, tonnage of steelwork/reinforcement, area of formwork, length of pipe work, etc.).
- (h) Work shifts (e.g. single, double, or triple shifts).
- (i) Work weeks (5, 6, or 7 day work week).
- (j) Production rates.
- (k) Holidays and special non-working days.
- (l) Other details as appropriate or required by Employer.

A202.2.7 The overall programme duration shall take into account all statutory holidays and any other applicable construction industry or corporate holidays. It shall also show the impact of seasonal monsoon periods.

A202.2.8 The base unit of measurement of activity duration will be one calendar day. The Contractor shall specify the normal weekly hours to be worked for all labour and major items of plant.

A202.2.9 The Contractor shall indicate on the Activity/Time Chart, the critical path, and shall indicate which activities (related to design and construction as appropriate) shall be undertaken on a twenty-four (24) hour per day basis (if approved by the Employer) and show the time for each activity in sufficient detail to enable an assessment to be made of the progress of the activities toward completion of the Works.

- A202.2.10 If the Employer is of the opinion that the detailed time programme (DTP) submitted by the Contractor does not enable the Employer to readily evaluate the Contractor's progress, the Contractor shall, upon being so notified by the Employer, continue to submit amendments (within seven days) of the DTP until the said programme is approved by the Employer. If so required by the Employer, the Contractor shall amplify or further breakdown any part of the design and/or construction phases of the programme.
- A202.2.11 The Employer shall review the programme for its adherence to Contract and scope of works but shall not be responsible to ensure that the programme will result in the required timely completion of the Works.
- A202.2.12 At such time that the DTP is approved in writing by the Employer, it shall become and, thereafter, be referred to as the approved Contract Programme. The Contractor shall adhere to and perform the Works in accordance with the approved Contract Programme unless otherwise agreed in writing by the Employer.
- A202.2.13 The Contractor acknowledges that the Employer will rely upon the approved Contract Programme in co-ordinating other works within site.

Updates of Contract Programme

- A202.2.14 The Employer may, from time to time, direct the Contractor to supply to the Employer with an updated contract programme. The Contractor shall within seven (07) days after the receipt of such a direction supply to the Employer an updated contract programme and shall continue to submit amendments of the contract programme until it is approved by the Employer. The Contractor shall comply with the approved updated contract programme when so approved by the Employer.
- A202.2.15 Once the first Contract Programme (Baseline) has been accepted by the Employer, the Baseline version as included within this document (the 'Original Accepted Baseline',) must be incorporated (un-amended), within all of the Contractor's future Contract Programme (DTP) updates and revisions.
- A202.2.16 If it is considered necessary to prepare, at a later date, any DTP revised baseline(s) each revision must be submitted together with any substantiating information, to the Employer for review and comment. The Contractor must not incorporate a revised baseline into any DTP updates or any DTP revisions unless the Employer has provided written acceptance for the revised baseline's incorporation. All DTP updates and DTP revisions must incorporate the original accepted baseline, in addition to any subsequently accepted revised baselines.
- A202.2.17 In the event of the Employer notifying his acceptance for the incorporation of a revised baseline, then the Contractor must, as part of his next submitted DTP revision or DTP update, identify each amended activity as part of the accompanying DTP narrative report.

Revision of Contract Programme

- A202.2.18 The Contractor may from time to time submit a revised Contract Programme with the purpose of re-organisation of the execution of the works so as to enable the Contractor to complete the works in the shortest practicable time. The revised Contract Programme must first be approved by the Employer and, if and when, such approval in writing is given, the Contractor shall comply with the revised Contract Programme.

Effect of Acceptance or Approval of Contract Programme

- A202.2.19 The acceptance or approval by the Employer of a Contract Programme, or revision thereof, shall not relieve the Contractor of its obligation to complete the works within the contracted time for completion and will not give rise to a variation under the contract.

A202.3 Work Progress Reporting

- A202.3.1 During the performance of the design and construction Works, the Contractor shall submit to the Employer, progress reports as defined in this specification and in the format required by the Employer in both hard copy and in a digital format. These submissions will continue until the Contractor has completed all work known to be outstanding at the completion date stated in the Taking-Over Certificate for the works.

Daily Site Records

- A202.3.2 The Contractor shall maintain daily records of the number of each class of the Contractor's Personnel and of each type of Contractors Equipment on the site along with brief description of the actual construction activities undertaken each day at site, safety mishaps (including all injuries) and any environmental issues/mishaps, coordination issues, and any other noteworthy activities or events.
- A202.3.3 These records shall be kept in the form of separate pro-forma Daily Site Record Forms corresponding to each day throughout the Works. The Contractor shall finalise the format of the Daily Site Record Form with the Employer prior to the commencement of the design works and construction works on site.
- A202.3.4 The Contractor shall present the Daily Site Record Form to the Employer (or delegated representative) each day for acceptance. Once agreed, the Contractor and the Employer shall both sign the Daily Site Record Form and each shall retain hardcopy of the signed form for record purposes.
- A202.3.5 The Contractor shall note that the requirements of this Clause are separate from and additional to the requirements of the Conditions of Contract regarding records of the Contractors Personnel and Equipment.

Weekly Progress Reports

- A202.3.6 The Contractor shall submit at the end of each week to the Employer a Weekly Progress Report summarising significant progress or problems encountered during the preceding week in respect to all parts/phases of the works (design and construction) under the contract.

- A202.3.7 The Contractor shall finalise the format and content of the Weekly Progress Reports with the Employer prior to the commencement of design works and construction works on site.
- A202.3.8 The Weekly Progress Report shall also include but not be limited to:
- (a) Progress for that week in terms of all activities including design and construction. Construction progress will include quantities and production rates also.
 - (b) Key decisions required from the Employer in the next week.
 - (c) Key design and construction milestones and progress towards each.
 - (d) Major events for the upcoming week.
 - (e) Three week look-ahead programme indicating progress in the previous week and the activities planned for the next two weeks.
 - (f) Measurement of KPIs (S-curves for Actual vs Planned).
 - (g) Submittal and RFI logs.
 - (h) Safety Health and Environment (SHE) report with photographs.
 - (i) Records of manpower and equipment compared to programmed requirements.
 - (j) Approved Daily Site Record Forms applicable to that week as a separate appendix.

Monthly Progress Reports

- A202.3.9 In addition to the Weekly Progress Reports, the Contractor shall submit each month within seven (7) days of the last day of the period or the agreed cut-off date with the Employer, an overall Monthly Progress Report summarising the contents of the submitted Weekly Progress Reports for that month in respect to all parts/phases of the Works under the contract. The submission of the Monthly Progress Report shall be subject to the requirements of the Conditions of Contract and the additional requirements of this Specification. The Report shall indicate the progress and financial status of the works of the previous month. The Report shall accurately estimate the work completed on each activity, including design, procurement, engineering and construction activities on the approved DTP.
- A202.3.10 The Contractor shall finalise the format and content of the Monthly Progress Reports with the Employer prior to the commencement of design works and prior to commencement of works on site. In addition to information from the Weekly Progress Reports, the Monthly Progress Report shall also include, but not be limited to:
- (a) Executive Summary of previous month's events including a clear summary statement of the current progress position.
 - (b) Describe DTP current Critical Path.

- (c) Details of design progress including design interface coordination, started or completed during the month as related to the Temporary Works, Permanent Works and Shop Drawings.
- (d) Updated drawing register.
- (e) Total work progress at the end of the previous month with progress chart showing progress achieved as a percentage against planned progress.
- (f) State existing status, rate of progress, estimated time of completion and cause of delays (if any).
- (g) Description of work accomplished since submission of previous progress Programme.
- (h) Programme Update: Compare actual work (design and construction) status against the Contractor's Baseline Programme submitted in electronic format, indicating the following:
 - (i) Activity Description.
 - (ii) Original Duration.
 - (iii) Remaining Duration.
 - (iv) Current Early Start.
 - (v) Current Early Finish.
 - (vi) Planned Percent Complete.
 - (vii) Target Early Start.
 - (viii) Target Early Finish.
 - (ix) Actual Percent Complete.
 - (x) Date Variance.
 - (xi) Percent Variance.
- (i) S-curves for physical progress against planned.
- (j) Details of work for the next month (by site).
- (k) Safety and health performance reporting.
- (l) Information regarding any design changes.
- (m) Information regarding any variations.
- (n) Details of inspections and approvals required to proceed with Work.
- (o) Records of manpower, equipment etc. (compared to programmed requirements).
- (p) Information required from the Employer.

- (q) Environmental Monitoring reporting, including separate Waste Management reporting.
 - (r) Weather records.
 - (s) Records of delays and stoppages with supporting reasons.
 - (t) Value of work done.
 - (u) Actual and anticipated cash flow.
 - (v) Changes or additions to Contractors supervisory personnel since the preceding progress report.
 - (w) Causes of any delays.
 - (x) Proposed actions by the Contractor to restore the programme, including what is being done or what is planned to be done in each problem area.
 - (y) Identify anticipated problems or changes and present plan to deal with them so as to minimize or prevent delays.
 - (z) Status of equipment and material deliveries.
 - (aa) Request for Information (RFI) status.
 - (bb) Submittals summary and status.
 - (cc) Instructions summary and status.
 - (dd) Defects summary and status.
 - (ee) Schedule of warranties and guarantees.
 - (ff) Schedule of insurances and insurance claims.
 - (gg) Subcontracts awarded in the previous month.
 - (hh) Photography of salient activities pertaining to work progress in the month
- A202.3.11 Updates and revisions to required programmes and reports shall not modify or limit in any way, the Contractor's obligations to meet the Time for Completion.
- A202.3.12 Copies of the site progress photos for the month shall be provided in a separate appendix.
- A202.4 Notice to the Employer
- A202.4.1 Unless specified otherwise or elsewhere in this Specification, the Contractor shall give the Employer not less than 24 hours' notice in writing of the intended time for commencement of any construction activities at site to enable the Employer to make his arrangements for the inspection of operations on the site.

- A202.4.2 The Contractor shall also give the Employer not less than 7 days' notice in writing of the commencement of any preparation, construction or manufacturing activity occurring at the manufacturer's or supplier's site, or at a location not within the manufacturer's or supplier's site, of any article or material to be used in the works, whether by the Contractor or any Subcontractor, stating the time and place of the works such that the Employer may make his arrangements for the supervision or inspection of such works at the manufacturer's or supplier's site. The Contractor shall bear the costs for Employer costs for inspections at manufacturers/supplier's sites.
- A202.5 Photographic and Videographic Documentation
- A202.5.1 The Contractor shall arrange to take colour photographs throughout the works for the purposes of recording the overall progress of the works and recording details of each aspect of the Works or as otherwise directed by the Employer. The photographs shall be of acceptable quality and shall be taken by a professionally competent person with a digital camera having resolution in excess of 10 Megapixels and able to record the date of photographs taken in the prints. Salient activities and corresponding photography pertaining to work progress are to be attached to the corresponding monthly progress reports. Further, the Contractor shall arrange for videography (HD quality) of important events of the Works or as otherwise directed by the Employer.
- A202.5.2 The Contractor shall submit to the Employer weekly six sets of CD/DVDs each containing the electronic files of each photograph/video taken as both, a) uncompressed, full resolution files and, b) compressed, reduced resolution files suitable for attachment to email (i.e. <1MB per file). The Employer shall select the photographs to be retained and the Contractor shall mount two hardcopy prints of each selected photograph in albums of acceptable quality. The albums shall be kept by the Contractor and produced to the Employer upon request and shall be handed over to the Employer at the completion of the Works. A compact disc containing the electronic files for the selected photographs shall be supplied each week. Each photograph in the album shall be suitably captioned and the electronic files appropriately named.
- A202.6 Six Monthly Report
- A202.6.1 The contractor shall submit draft reports on six monthly returns to be sent to Central Pollution Control Board, Bengaluru within 7 days of the last day of the period in hard and soft copies, in consultation with the employer.
- A203 **Contractor's Design Work**
- A203.1 General
- A203.1.1 It is the Employer's intent that the Contractor will analyse the Employer's Requirements thoroughly and use their full creativity to complete the design. The Employer intends to allow the Contractor maximum flexibility to design and produce a set of full, thorough and state-of-the-art, sustainable facilities and infrastructure.

- A203.1.2 The Employer has provided the Employer's Requirements in Section 7 of these documents. These documents are intended to provide the Contractor with sufficient information so as to clearly understand the Employer's intent, goals and objectives in execution of the works. The Contractor will be required to adopt the general concepts, as provided, and expand and develop the same to produce complete, thorough, comprehensive and high quality designs, working drawings, and specifications for review and approval by the Employer. While developing the complete and final designs and specifications, the Contractor shall review the concepts design and planning for betterments or improvements which may be incorporated to better achieve the Employer's goals and objectives and which may result in overall improved functionality. These betterments, if any, shall be submitted by the Contractor to the Employer for review and for the approval by the before the final design is completed.
- A203.2 General Design Obligations
- A203.2.1 The Contractor shall prepare the full and complete design and drawings for the Works as per the Contract.
- A203.3 Design Method Statement
- A203.3.1 Prior to the commencement of any design works, the Contractor shall submit to the Employer for approval, as part of the 120-day Preliminary Program, a Design Method Statement as outlined below describing how he intends to manage, control, programme and carry out the necessary design work in accordance with his obligations under the Contract. It will include:
- (a) The proposed design organisation.
 - (b) Programme of the design work.
 - (c) A Design QA/QC plan, certification and procedures.
 - (d) An integrated schedule of staged/segmented, sequential design, construction and supporting activities that results in the earliest possible completion and Employer's Taking-Over of Section I (complete and usable) and the complete Works (Section II).
- A203.3.2 For each stage, the Contractor will submit a design package that has all of the elements/components required for 100% design of the stage. All planning documents, calculations, applicable codes and specifications, design guidance and ready-for-construction drawings with complete construction details, must be included.
- A203.4 Design Requirements
- A203.4.1 Design requirements are contained in multiple parts of the Contract Documents. The Contractor shall scrutinise all of the documents to ascertain all of the design, design process, design quality and design management requirements for inclusion in the Design Method Statement.

- A203.4.2 The Contractor shall be deemed to have scrutinised, prior to the Commencement Date, the Design Criteria, Specifications and Drawings and all subordinate and supporting documents. The Tender Documents contain concept design drawings and specifications provided by the Employer. The Contractor shall use these concept drawings and specifications provided and develop them further in parts and in the whole to full and final design, ready for construction purposes. The Contractor shall be responsible for the design and specifications of the whole of the Works. They are also responsible for the redesign and re-specification of all parts of the Works described in the Tender issued by the Employer that are affected in any way by the designs of the Contractor, and for the accuracy of that part of the Specifications and the Drawings relating to such design (including design criteria and calculations).
- A203.4.3 The Employer shall not be responsible for any error, inaccuracy or omission of any kind in the Design Criteria, Concept, Specifications or the Drawings as originally included in the Contract and shall not be deemed to have given any representation of accuracy or completeness of any data or information, except as stated specifically. In the event of, if finding a discrepancy, difference or conflict between documents, then the resolution, thereof, shall be interpreted and applied to the benefit and in favour of the Employer. Any data or information received by the Contractor, from the Employer or otherwise, shall not relieve the Contractor from his responsibility for the full, thorough and complete design of that part of the Works to be designed by the Contractor as required under the Contract and for the execution of the Works.
- A203.5 Contractor's Designer(s)
- A203.5.1 The Contractor shall carry out, and be responsible for, the full and complete design of the Works. Design shall be prepared by a qualified design firm or a consortium of design firms jointly complying with the following criteria:
- (a) Successfully completed detailed design pertaining to Piled Jetty (comprising of over 100 piles) over the past 7 (seven) years ending last day of month previous to the Tender Due Date.
 - (b) Successfully completed Structural design of Building of total floor area of 2,000 Sq.m over the past 7 (seven) years ending last day of month previous to the Tender Due Date.
 - (c) Successfully completed Building Mechanical, Electrical & Plumbing (MEP) design for total floor area of 2,000 Sq.m over the past 7 (seven) years ending last day of month previous to the Tender Due Date.
- A203.5.2 Unless otherwise stated in the Contract, the Contractor shall submit to the Employer for review and approval the name and particulars of the design firm and the key personnel proposed to be involved in design alongwith his technical proposal.

- A203.5.3 Within 30 days of Commencement Date, the Contractor shall re-submit the credentials of design firm, who shall carry out the design works for this contract. The following shall be submitted for the approval of the Employer;
- (a) Profile, details and experience of the design organisation.
 - (b) Completion certificates confirming that the design firm meets the qualification criteria as mentioned in A203.5.1
 - (c) Full and detailed CVs of persons proposed to be deployed.
- A203.5.4 Approval of the design firm shall be subject to the specific written approval of the Employer.
- A203.5.5 The Contractor warrants that he, his design firm, designers and design Subcontractors, if any, have the experience and capability necessary for producing a complete, thorough and quality design that meets or exceeds all Employers Requirements and complies with all applicable codes. The Contractor is required to ensure that the key personnel of the design firm shall be available to attend meetings and/or discussions with the Employer, as may be required by the Employer, until the expiry of date of the relevant Defects Notification Period.
- A203.6 Contractor's Documents
- A203.6.1 All Contractors' Documents shall be submitted to the Employer for review in accordance with the procedures outlined herein and in accordance with the requirements of the Conditions of Contract.
- A203.6.2 The Contractor shall prepare all and any Contractor's Documents and shall also prepare any other documents necessary for successful completion of the Works with required quality and within established and approved schedules. Such preparation shall include review (including Third Party Review, detailed below), verification and warranting of the Contractor's Documents by Designer(s), approved by the Employer as specified above. The Employer shall have the right to inspect the preparation of these documents, wherever they are being prepared.
- A203.6.3 Contractor's Documents shall comprise the following items and any other documents that may be requested by the Employer:
- (a) Design Basis
 - (i) This document shall provide all information which the Contractor intends to use as the basis for preparation of approvals, construction drawings, monitoring and construction specifications.

- (ii) This document shall also detail the design parameters for each Material to be used in the work, and shall include preliminary testing results which verify that the available Material is in accordance with the proposed design parameters.

(b) Detailed Design, Construction Drawings and Specifications

- (i) The design shall include full design calculations and drawings and shall provide the full and detailed design of the Works showing the Contractor's application of the Employer's Requirements and any other data the Contractor reviewed or obtained, including details of any proprietary products to be used.
- (ii) The design shall include clear details of any acceptance criteria and settlement triggers to be used when assessing the removal of preload or the completion of ground improvement works.
- (iii) The drawings shall be the drawings which the Contractor intends to use for the construction of the Works.
- (iv) The specifications shall be the specifications which, when read in conjunction with the drawings, shall describe the materials and workmanship to be used for the construction of the Works.

(c) Testing and Monitoring Regime

- (i) The Contractor shall submit with each part of his design, details of the testing regimes that he will implement to demonstrate that the As-Built Works comply with his design.

A203.6.4 All Contractors' Documents shall include revision numbering and issue dates.

A203.6.5 As part of the Contractor's 120-day Preliminary Programme, and the subsequently detailed and maintained DTP, the Contractor shall submit all Contractor's documents required as per Employer's Requirements, the DMP and other documents as required or directed by the Employer. All design submissions will have been identified and contained in the Design Method Statement.

A203.7 Design Review

A203.7.1 The Employer through PMC will provide a high level review of the design works and will also perform a structural review of the design of critical structures performed by contractor's designer(s), If on structural review by the Employer the design is found to be acceptable, then the Employer will issue a notice of no objection. The contractor will submit the structural review of critical structures segments to the TPR (below) for review prior to submitting to the Employer.

A203.7.2 The Employer’s high level review is for general compliance with the criteria, scope of work and intent of the Contract in accordance with the Specifications and the Drawings. The Employer’s high level review may not cover the technical or engineering part of the Contractor’s Documents. The Contractor remains solely and totally responsible for the thoroughness and quality of the Contractor’s Documents.

A203.8 Classification of Contractor’s Documents

A203.8.1 Following review of the Contractor’s Documents, the Employer shall reply to the Contractor with a classification of the Contractor’s documents as follows:

Classification Category	Definition	Action by Contractor
1	The Contractor’s Document is acceptable without comment.	Contractor may proceed with construction.
2	The Contractor’s Document is acceptable subject to changes or clarification requested by the Employer.	The Contractor shall make the changes requested prior to commencement of construction.
3	The Contractor’s Document is unacceptable for the reasons given by the Employer. Construction work shall not commence.	The Contractor shall revise the document and re-submit to the Employer for further review.

Third Party Reviewer (TPR)

A203.8.2 All technical design submittals (designs, drawings, calculation etc. in paragraph above) prepared by Contractor shall be thoroughly reviewed and approved by the TPR prior to submission to the Employer. The TPR shall be IIT Chennai or IIT Mumbai or IIT Delhi or IIT Kanpur or institution of International Repute subject to the approval of the employer, at no additional cost to the Employer.

A203.8.3 The scope, roles and responsibilities of the TPR shall be submitted by the Contractor and approved by the Employer. These primary roles and responsibilities should include, but not be limited to:

- (a) Thorough review of all design, technical and specification documents provided from the Contractor design team. The Contractor, at his own discretion, can determine how best to utilise the services of the TPR to maximize efficiency and completeness while maintaining schedule integrity.

- (b) The TPR shall endeavour to ensure that the proposed designs and specifications meet the goals and objectives of the Project. The review will also include detailed review for functionality, quality, form and fit, safety, efficiencies, interfaces, technical adequacy and solutions, relationships to adjacent systems and structures, cost effectiveness, sizing, sustainability, etc. Additionally, improvements, if any, shall be noted.
- (c) Specifications review to ensure that the technical specifications are properly coordinated with the design, properly describe the components and material to be incorporated into the design and facilities, provide enough and proper detail for the bidders to understand the requirements, and are otherwise thorough and complete.
- (d) Identify, review and validate all applicable technical, regulatory and referenced codes and specifications to ensure compliance.

A203.8.4 The Contractor will ensure proper and effective coordination of the TPR including related review conferences which may include some combination of the following:

- (a) Traditional review - Contractor submits design documents to the TPR and stops work while the review process occurs for each segment/phase of the Contractor's design submission.
- (b) In-progress review - Same as traditional review except the Contractor continues design effort while the TPR reviews.
- (c) On-board review – TPR and the Contractor visit the activity to review the design documents submitted by Contractor; designated on board/ in progress, or on board/ traditional depending on whether or not the Contractor continues or stops work while the TPR reviews.

A203.8.5 If through TPR or other means, it is determined by the Employer that the design is inadequate and deficient and not meeting project goals and objectives, the Employer, will require the Contractor to immediately provide a resolution and correction plan, that will ensure mitigation of the deficiencies and achieve the design quality and standard as required by contract.

A203.8.6 The Contractor will account for all TPR reviews and follow-ups in the Contract Programme.

A203.8.7 It will be the responsibility of the Contractor, acting in a professional capacity, to ensure accuracy, completeness, and correctness of the design, cost estimate and all engineering concepts and details of the work, including coordination of the various architectural, civil, structural, mechanical, electrical, and other subdivisions thereof with each other and with the specifications.

A203.8.8 The Contractor shall establish a review comment capture, tracking, status, responsibility, and resolution tool software (such as MS Excel) that will be used by the TPR, but in any case, TPR shall input all required details (timely and accurately) into the PMIS.

Design Review Process

A203.8.9 The Contractor shall submit to the TPR all elements of the Contractor's Documents prior to commencing any work on Site.

A203.8.10 Submissions shall be made in stages to the TPR/Employer appropriate to the Contractor's design development and in accordance with the agreed programme.

A203.8.11 After the TPR's review achieves a category "2" status, the Contractor's Documents shall be subject to review by the Employer, in accordance with the requirements stated above.

A203.8.12 Unless otherwise stated in the Employer's Requirements, each review period shall not exceed 21 days, calculated from the date on which the Employer receives a Contractor's Document and the Contractor's notice. This notice shall state that the Contractor's Document is considered ready, both for review (and approval, if so specified) in accordance with this sub-clause and for use. The notice shall also state that the Contractor's Document complies with the Contract, or the extent to which it does not comply. No extension of time shall be considered for any delay related to this review. No work shall start on site until the TPR/Employer's reviews achieve category "2" status.

A203.8.13 If at any time, the Contractor makes a change to any Contractor's Documents, the Contractor shall re-submit the Contractor's Document for further review and the above procedure shall again be adhered to.

A203.8.14 The Contractor shall acknowledge and accept any designs which were not prepared by the Contractor and which form part of the Contractor's Documents and takes responsibility for such designs as if they were prepared by the Contractor.

A203.8.15 All submissions shall be in electronic format (AutoCAD + working calculation files plus record copy in PDF format) and hardcopy. The design submission shall include detailed design calculations, results / recordings of all investigation work, and detailed drawings.

A203.8.16 The Employer may, within the review period, give notice to the Contractor that a Contractor's Document fails (to the extent stated) to comply with the Contract. If a Contractor's Document so fails to comply, it shall be rectified, resubmitted and reviewed again (and, if specified, approved), at the Contractor's cost and time.

A203.9 Quality Review

A203.9.1 The Contractor is required to implement a highly effective and thorough QA/QC program as stated in subsequent paragraph. The Contractor will ensure that the final design is complete and thorough and meets all quality standards as contained in the Contractors Quality Management Plan and meets the Employer's Requirements.

A203.9.2 Examination and/or approval by the Employer of any drawings or other documents submitted by the Contractor shall not relieve the Contractor of his obligations, responsibilities or liabilities under the Contract.

A203.9.3 If the Employer instructs that further Contractor's Documents are required, the Contractor shall prepare them promptly.

A203.9.4 Nothing done or omitted by the Employer shall relieve the Contractor of his duty or responsibilities or liabilities under the Contract.

A203.10 Contractor's Undertaking

A203.10.1 The contractor shall undertake that the design of that part of the Works to be designed by the contractor will be in accordance with:

- (a) The Laws, Regulations and Codes of the Country;
- (b) All documents forming the Contract ; and
- (c) All MoEF&CC requirements and obligations.

A203.10.2 The Contractor shall be responsible for the completion of the design of the Works, and when the Works are completed for ensuring, that they are fit for such purposes for which the part or whole is intended as are specified in, or implied by, the Contract. Nothing done or omitted by the Employer shall relieve the Contractor of his duty or responsibilities or liabilities under the Contract.

A203.11 Technical Standards and Regulations

A203.11.1 The design of the Works to be designed by the Contractor shall comply with the country's technical standards, building, construction and environmental laws, laws applicable to the product being produced from the Works and other standards specified in the Employer's Requirements, applicable to the works, or defined by the applicable laws.

A203.11.2 If changed or new applicable standards come into force in the Country after the prescribed dates mentioned in Employer's Requirements, the Contractor shall give notice to the Employer and (if appropriate) submit proposals for compliance. In the event that:

- (a) The Employer determines that compliance is required,
- (b) The proposals for compliance constitute a Variation, and
- (c) Then the Employer shall initiate a Variation in accordance with relevant Clause.

A203.12 Design Error

A203.12.1 If errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the Contractor's Documents, they and that part of the Works to be designed by the Contractor shall, subject to the approval of the Employer, be corrected at the Contractor's cost and time, notwithstanding any consent or approval under this Clause.

A204 SUBMITTAL PROCEDURES

A204.1 General

A204.1.1 All Communications submitted by the Contractor as defined in the Conditions of Contract shall have a unique sequential reference number to facilitate tracking of the Contractors submissions and correspondence by the Employer.

A204.1.2 Contractor's submission shall be made in both hard and native soft copy format to the Employer, as specified or requested by the Employer. The cost of submissions to the Employer in all formats shall be deemed to have been included in the Contract Price.

A204.2 Requests for Information

A204.2.1 Where the Contractor requires additional information or clarification in order to carry out the Works, or where he identifies any ambiguity or inconsistency in the Contract Documents he shall immediately submit to the Employer a Request for Information (RFI). The response for RFI shall normally be given within seven(7) days after receiving the same.

A204.2.2 The Request for Information forms shall be provided with a sequential number or reference to facilitate tracking by the Employer.

A205 NOTICE TO THE EMPLOYER

A205.1.1 Unless specified otherwise elsewhere in this Specification, the Contractor shall give the Employer not less than 24 hours' notice in writing of the intended time for commencement of any construction activities to enable the Employer to make his arrangements for the inspection of operations on the Site.

A205.1.2 The Contractor shall also give the Employer not less than seven (07) days' notice in writing of the commencement of any preparation, construction or manufacturing activity occurring at the manufacturer's or supplier's site, or at a location not within the manufacturer's or supplier's site, of any article or material to be used in the works, whether by the Contractor or any Subcontractor, stating the time and place of the works such that the Employer may make his arrangements for the supervision or inspection of such works at the manufacturer's or supplier's site.

A300 REGULATORY REQUIREMENTS

A301 PERMITS, PERMISSIONS AND STATUTORY APPROVALS

A301.1.1 The Contractor shall comply with all statutory obligations and regulations of relevant Authorities or services or utility providers, or any other relevant body or organisation with authority or jurisdiction in India relating to the execution of the Works.

A301.1.2 Where any conflict arises between the requirements of the various relevant authorities, the more stringent provision shall apply subject to the agreement of the relevant authorities.

A301.1.3 The Contractor shall allow sufficient time in his programme for the issue of any statutory notices by the relevant Authorities which may be required prior to the commencement of the relevant Works. The Contractor shall provide the Employer with documents of evidence that the relevant Authorities have been notified of the proposed Works in accordance with relevant regulations and ordinances.

A301.1.4 The Contractor shall give notice to the relevant Authorities at least one month or as appropriate to get the necessary approvals in advance of commencement of any new activity and shall keep the relevant Authorities regularly informed of the Works. The Contractor shall liaise with the relevant Authorities to give all information on working areas, types of plant and durations of activities, deemed necessary by the Authorities. The Contractor shall if required, also advise the Authorities on completion of each and every separate activity. In particular, at least one months' notice shall be given to the Authorities for the removal or relocation of any navigation affected by the Works.

A301.1.5 The Contractor shall identify the permissions and submissions that are required by the regulatory Authorities for the performance of the Works. Where required, the Contractor shall prepare and submit to the relevant Authorities for their endorsement details of the proposed construction sequence and methods to be employed on the Works and an action plan as required in the Contract. No construction work shall be commenced prior to the endorsement and approval of the relevant submissions by Authorities. In this respect the Contractor shall note that the Authorities' requirements may include the submission of the following for their approval at least one month in advance of the commencement date of the Works.

Detailed plans of the landside and marine Works showing the proposed overall limits of the working area(s) and the space requirements of each of the operations.

List of all personnel who would be working at site.

Name of the person(s) in charge of the Works who can be contacted by the relevant Authorities on a 24-hour basis and means and procedures to contact them.

Proposed schedule of all Works carried out under the Contract indicating different types of operations, their number, duration, space requirements and phasing.

A full description of the method for all work activities including the number and type of plant / craft to be employed, together with a complete list of vessels and craft to be used for all types of marine Works.

Details of weather conditions in which operations would cease and all working marine craft would be removed from the working area; Other as may be required.

A301.1.6 Health Safety & Environment permits and all related issues are the responsibility of the Contractor. All correspondence between the Contractor and relevant Authorities including all submissions shall be copied to the Employer. All environmental permitting issues will be dealt through Employer.

A302 HEALTH AND SAFETY REQUIREMENTS

A302.1 General

A302.1.1 The Contractor shall comply with all health and safety requirements of the Contract including statutory requirements, requirements of Kerala State Government Department, requirements stipulated, and any reasonable direction issued by the Employer's safety department or authorised personnel of the Employer from time to time. The Contractor shall document, implement and maintain a safety system complying with international standards acceptable to Employer.

A302.1.2 All works shall be carried out in a safe manner and free from any danger and shall comply with the relevant Laws regarding safety of the Works.

A302.1.3 The Contractor shall take all precautions necessary to protect the health and safety of persons where works may expose workmen and other persons on, or within the vicinity of the site, to conditions which are dangerous or potentially dangerous to health, including the noxious effects of dust, fumes, liquids, infection, fire, explosion, or other hazards. Any identified hazard posing risk of bodily harm to personnel or property damage shall be rectified immediately.

A302.2 Health and Safety Manager

A302.2.1 The Contractor shall have in place a qualified experienced and proactive Health and Safety Manager approved by the Employer prior to commencing the Works. The Contractor's Health and Safety Manager shall have good communication skills (written and spoken). The officer so designated shall be made known to all employees by the posting of his name, designation and photograph in prominent positions on Site. Provision shall be made to provide adequate communication with all members of the work force.

- A302.2.2 The Health and safety Manager in addition to Employer, or any Employer's representative, shall have full written authority from the Contractor to stop work in the event that he deems necessary or any condition which may pose 'Imminent Danger to Life and Health' (IDLH) to any person or safety. He/she shall be fully familiar with pertinent safety requirements and policy as contained in statutory requirements, the Employer HSE Plan, the Contractor's HSE Plan, and any other regulatory document pertaining to safety in the workplace in India.
- A302.3 Health and Safety Management Plan
- A302.3.1 The Contractor shall prepare and submit for approval a Health and Safety Management Plan (HSMP) complying with the requirements of the Contract, the Employer's HSE Plan, and international best practice and with Indian and local laws and regulations and which shall be implemented throughout the Works. The plan shall describe the responsibilities and procedures for all aspects of the safety management on the Works and shall be capable of regular audit throughout the course of the Works.
- A302.3.2 The Contractor shall submit the HSMP to the Employer within 28 days of the Contract Commencement Date or at least 14 days prior to the intended commencement of any permanent Works under the Contract, whichever is the earlier. The Employer will take maximum 14 days for issuing comments (if any) to be incorporated by the Contractor.
- A302.3.3 The resolution of such comments on the HSMP submission to the satisfaction of the Employer and the subsequent acceptance of the HSMP by the Employer shall constitute a Hold Point on the commencement of any permanent Works under the Contract.
- A302.3.4 The Contractor shall ensure its HSMP include:
- (a) Safety Policy Statement of Senior Management and a project responsibility matrix;
 - (b) Normal protocols for personnel requiring access into and out of working areas;
 - (c) Emergency plans (in line with existing Emergency and Disaster Management Plans for the project) for all identifiable potential incidents such as fires, foundering, oil spills and the like;
 - (d) Requirements for routine internal safety audits;
 - (e) Drills frequency and type. Drills shall be separated into those required for statutory or insurance purposes and additional drills proposed for the Works. Vessels and crew training shall meet the safety requirements of the Contract and all applicable regulatory requirements or as indicated by Central, State or Local Government statutory authorities and bodies;
 - (f) Emergency evacuation procedures, lifeboat and evacuation drills and other emergency response equipment;

- (g) Certification of crane drivers/vessel operators, in full compliance with Indian requirements;
- (h) Job Hazard Analysis. The Contractor shall provide written working procedures, directions including Job Hazard Analysis or Job Safety Analysis (JHA/JSA) and undertake drills on all equipment in order to ensure the safe and timely execution of the Works. JHA/JSA, procedure revisions and drills shall be ongoing during the course of the Works according to a programme approved by the Employer and set out in the Health and Safety Management Plan; Based on JSA and anticipated risks, mitigation measures for activities planned, based on hierarchy of control will be developed and submitted to Employer for approval;
- (i) Work over and on water specific risks and mitigations;
- (j) Firefighting and emergency breathing apparatus;
- (k) Hazardous and explosive materials register and storage;
- (l) Project specific Contractor's site safety instructions for Contractor's Personnel, Employer's Personnel Visitors;
- (m) Any onshore or offshore activities which cannot be undertaken 24 hours per day due to safety or other constraints;
- (n) Accident / Near Miss investigation procedures;
- (o) Competency testing;
- (p) Employee training;
- (q) Tool Box Meetings, Work Area Inspections; Signage, First Aid facilities and trained personnel;
- (r) Equipment lock out procedures;
- (s) Confined space access procedures;
- (t) Auditing frequency;
- (u) Reporting;
- (v) Contractors Anti-Child Labour Policy or statement.

A302.4 Training

A302.4.1 All personnel shall be suitably qualified, experienced and trained by the Contractor for the equipment or duty that they are engaged on.

A302.4.2 A sufficient number of the Contractor's employees who speak the language of the State/region shall be fully qualified in first-aid so that first- aid will be immediately available in case of accident at any time and at any place throughout the Site and any off-site camps, housing or other facility. The persons so designated shall be made known to all employees by the posting of their name, designation and photograph in prominent positions on Site. Such first-aiders or medical service providers shall be trained.

A302.5 Substances Hazardous to Health

A302.5.1 The Contractor shall not use or generate any material in the Works which are hazardous to the health of persons, animals or vegetation. Where it is necessary to use some substances which can cause injury to the health of workers/environment, the Contractor shall provide protective clothing or other appliances for security of his workers or requisite control measures to prevent effect on environment, as approved by the Employer.

A302.6 Safety Audits

A302.6.1 The Contractor's Head Office personnel qualified and experienced to do so, shall undertake audits of the site management performance and project operations during the Works in order to evaluate the degree of compliance of the Contractor's site operations to the Contract requirements for Health and Safety.

A302.6.2 Audits shall be undertaken by an audit team. The audit team shall consist of the Contractor's Head Office Representative (team leader), a Representative of the Employer and Employer. An audit agenda based on the Contractor's commitments will be prepared and agreed prior to the audit.

A302.6.3 Any audit shall follow the normal procedure for this type of activity with an Entry Meeting, the Audit and a Close-out Meeting where preliminary findings will be discussed direct with the Contractor's project staff. An audit report shall be prepared and agreed by the audit team. Non-compliances shall be actioned by the Contractor.

A302.6.4 Based on the audit, the audit team will issue an audit report, indicating the site Health and Safety Performance based on performance indicators as internationally acceptable in the industry. The Audit report will also have corrective and preventive action plan based on risk grading. The contractor is to develop the findings closure plan and issue a compliance report fortnightly based on findings and severity.

A302.6.5 Contractor shall routinely audit the use of training aids and drills and provide training and direction to the project management staff and to all supervisors and crews.

A302.6.6 The Contractor's head office personnel shall arrange regular audits of all project management personnel against documented company procedures and Indian Occupational Health and Safety Law and Regulations.

A302.6.7 The Employer shall be entitled to hold a Health and Safety audit of the Contractors safety procedures and the practices on site at any time with no notice. The contractor shall provide all required assistance to the Employer in this respect including access to appropriate information, site areas and personnel. The costs of this assistance shall be borne by the Contractor and no delays shall be attributable to such audit activities. Such audits will be undertaken quarterly or six monthly as per Employers discretion.

A302.7 Incidents and Accidents

A302.7.1 Incident and Accident reporting and statistics shall be undertaken to the relevant Indian Standard, Employer's and Contractor's requirements.

- A302.7.2 The Contractor shall send, to the Employer, details of any accident on or about the Site or in connection with the execution of the Works, as soon as practicable and, in any event within 24 hours after its occurrence. The Contractor shall also report such accident to the appropriate Authority whenever such report is required by the Laws. In the case of any fatality or serious accident, the Contractor shall in addition notify the Employer immediately by the quickest available means. Investigation techniques of Root Cause Analysis (such as Five Why, Causal tree Analysis or Fish bone Analysis, etc.) shall be used by the Contractor.
- A302.7.3 If an accident results in an injury to an employee or damage to equipment or release of hydrocarbons from the vessel or requires evacuation of personnel from floating equipment, oil spill clean-up, subsequent hospitalization of any individual or major repairs to equipment the Contractor shall arrange for a qualified independent third party investigation and report. The third party investigator shall be approved by the Employer.
- A302.7.4 A preliminary report shall be prepared and submitted to the Employer within 24 hours and a detailed report shall be submitted within seven (7) calendar days of the occurrence of the accident or incident. Should any construction activity need to stop work for:
- (a) The duration of the investigation, attendance of witnesses etc.;
 - (b) Modifications to safety plan, Job Safety/Hazard Analysis;
 - (c) Modification and validation of work procedures;
 - (d) Government Agency inspections and procedures;
 - (e) Any other reason;
- A302.7.5 All costs associated with the delay shall be at the cost of Contractor.
- A302.7.6 The Contractor's attention is drawn to the likelihood that any downtime resulting through loss of life, limb or other serious accident or incident may be considered as prima facie evidence that the Contractor's Works and Safety Management Plan and or Environmental Management Plan procedures and recruitment and training system are inadequate and/ or deficient. The Employer and other Agencies may require a complete reworking and independent audit of the Contractor's safety system and job safety analysis sub elements and environmental protection procedures. The cost of such delays and reworking of procedures caused by such activities will be at the cost of Contractor.

A303 ENVIRONMENTAL REQUIREMENTS

A303.1 General

- A303.1.1 The Contractor shall take all precautions for safeguarding the environment during the course of the execution of the Works. He shall abide by all laws, rules and regulations in force governing pollution prevention/abatement and environmental protection that are applicable in the area where the Works are situated/ carried out.

- A303.1.2 The Contractor is bound to strictly adhere to the Environmental and Social Impact Assessment (ESIA) shared by the Client. Any violation to the ESIA requirement shall incur a fine of one thousand (Rs. 1000) for the first violation, second violation will attract a fine of ten thousand rupees (Rs. 10,000) and the third violation onwards can lead to a fine of fifty thousand rupees (Rs.50,000) followed by Termination of Contract.
- A303.1.3 The Contractor shall observe and comply with all environmental requirements (including all applicable laws, regulations and any requirement of any relevant Authority (central/state or regional regulatory authority) and any directions of the Employer), the requirements of the Environmental Clearance and other Permits for the permanent Works as held by the Employer and any other requirements that apply to the Site generally.
- A303.1.4 The Contractor shall apply for and obtain Environmental Permits as applicable for the execution of the Works from the relevant Indian Authorities (central/state or regional regulatory authority) before commencing work on site. The Contractor shall submit a copy of such Permissions / Approvals obtained by him for the execution of Works.
- A303.1.5 The Contractor shall consider all Site conditions and adopt pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimize adverse impacts on human health and the environment. The principles and techniques applied during the Works shall be tailored to the hazards and risks associated with the nature of the task and consistent with applicable regulatory requirements and Best Management Practices (BMP) as appropriate.
- A303.1.6 The Contractor shall implement effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs during the execution, with a focus on areas that are considered for Work activities.
- A303.1.7 The Contractor will avoid the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release in compliance with regulatory requirements. This applies to the release of pollutants to air, water, and land due to routine, non-routine, and accidental circumstances with the potential for local, regional, and trans boundary impacts (if any). In case of any contamination (soil/groundwater/marine), Contractor shall be responsible for adequate clean-up (remediation) in consultation with Employer.
- A303.1.8 The Contractor shall be responsible for any environmental impact(s) due to its operations and shall be liable to undertake remedial measures in consultation with the Employer//regulatory authorities as the case may be.
- A303.2 Construction Environmental Management Plan (CEMP)
- A303.2.1 The contractor shall submit a Construction Environmental Management Plan within 28 days of the Contract Commencement Date or at least 14 days prior to the intended commencement of any permanent Works under the Contract, whichever is the earlier. The Employer will take maximum 14 days for issuing comments (if any) to be incorporated by the Contractor.

A303.3 General Environment Management

A303.3.1 Permits: Contractor, in consultation with Employer, shall ensure that all applicable Permits/Licenses/Certificates/No Objection Certificate required for construction works shall be obtained prior to commencement of works.

A303.3.2 The Contractor shall ensure that applicable Permits (as and when applicable) are obtained well on time and provide copy of application submitted along/or with license obtained to Employer. The Contractor shall ensure that the permits are valid at any given point of time.

A303.4 CEMP shall include the following:

A303.4.1 Adequate precautions shall be taken during transportation of the construction material so that it does not affect the environment adversely.

A303.4.2 All the recommendations mentioned in the EIA/EMP shall be implemented.

A303.4.3 The Contractor shall undertake monitoring of various aspects through an agency approved by MoEF&CC / CPCB / KSPCB or as defined in the permits obtained by the Contractor and furnish reports to the Employer.

A303.4.4 Notification of Accident/Incident: Kerala State Pollution Control Board (KSPCB) shall be kept informed of any accident or unforeseen act or event as a result of such water or air is being polluted.

A303.4.5 If noise and gaseous pollutants exceeds permissible limits, the Contractor shall propose and implement mitigation plan as per approval of the Employer.

A303.4.6 The Contractor must take all reasonable steps to minimize dust nuisance during the construction of the Works.

A303.4.7 Any structural damage caused to the existing roads by the Contractor's construction equipment shall be made good by the Contractor without any extra cost to the Employer. The wheels of the vehicles which are carrying construction material / demolished material are to be cleaned before entering the main road of the Naval Base.

A303.4.8 Dumping of debris in or nearby water bodies shall be strictly avoided. Waste products shall be collected, stored and taken to approved disposal sites as per norms.

A303.4.9 Noise, Vibration, pollution measuring instruments to be calibrated properly and certificates to be produced while conducting test.

A303.5 Air Emissions Management

A303.5.1 The Contractor must take all reasonable steps to minimize dust nuisance during the construction of the Works.

A303.5.2 All existing roads used by vehicle of the Contractor or any of his sub-contractors or suppliers of materials or plant, which are being used by traffic, shall be kept clean of all dust/mud or other extraneous materials dropped by the said vehicles or their tyres. Similarly, all dust/mud or other extraneous materials from the Works spreading on these roads shall be immediately cleared by the Contractor.

- A303.5.3 Clearance shall be affected immediately by manual sweeping and removal of debris, or, if so directed by the Employer, by mechanical sweeping and cleaning equipment, and all dust, mud and other debris shall be removed entirely from the road surface. Additionally, if so directed by the Employer, the road surface shall be hosed or watered using suitable equipment and adequate records of same shall be maintained.
- A303.5.4 Compliance with the foregoing will not relieve the Contractor of any responsibility for complying with the requirements of all relevant authorities in respect of the roads used by him.
- A303.5.5 Monitoring plan developed as part of CEMP shall include the following elements on air emissions management.
- (i) Monitoring to be for PM_{2.5}, PM₁₀, SO₂, Pb and NO_x carried out at one station in the project site.
 - (ii) Data on ambient air quality shall be submitted to the COPT and other regulatory and statutory bodies as directed by the Employer.
 - (iii) Monitoring shall be done twice a week, 4 weeks in a season (except monsoon) during construction.
 - (iv) Procedure for regular monitoring should be installed to ensure that emissions from DG sets are well below the prescribed emission standards for DG sets.
 - (v) The Contractor shall maintain log books to reflect working condition of Pollution Control Devices (PCDs) and also self-monitoring results and keep it open for inspection.
- A303.5.6 The Contractor shall ensure sprinkling of water on roads or Project area where general dust emission is high, especially if the construction area is near the residential areas.
- A303.5.7 Procedure for selection of construction vehicles/ machinery and maintenance shall be developed by the Contractor and shall include the following:
- (i) Vehicles are to be attached with latest pollution control measures and shall comply with relevant IS. Pollution Under Check (PUC) certificate of all vehicles to be maintained and kept.
 - (ii) Ensure vigorous maintenance and stringent overhauling to minimize gaseous exhaust fumes of dumpers, shovel and other heavy machineries. Develop preventive maintenance schedule of vehicles and submit compliance status at six monthly intervals.
- A303.6 Air Quality Monitoring
- A303.6.1 Air Quality monitoring in Construction areas shall be undertaken by the Contractor in compliance with EIA guidelines.

- A303.6.2 Respirable dust sampler with gaseous sampling attachment to be used for sampling of air for PM_{2.5}, PM₁₀, SO₂, NO_x for a period of 24 hours duration. Sampling analysis will be carried out as per IS-5182:1999, Indian Standards for measurement of air pollution.
- A303.7 Water and Waste Water Management
- A303.8 Water Usage
- A303.8.1 Contractor shall ensure the following for water usage in general for domestic and works:
- A303.8.2 There shall not be any groundwater drawl within CRZ area. Provision for water from other sources other than groundwater shall be ensured. No ground water is to be utilised for any construction activity.
- A303.9 Industrial Effluent Management
- A303.9.1 Workshop effluents: Effluents generated by servicing of the vehicles contain pollutants such as suspended solids, oil & grease. Oil and grease trap shall be provided to such effluents.
- A303.9.2 Settling tanks shall be provided for cleaning the waste water from the site workshop.
- A303.9.3 Effluent shall be discharged only to the place mentioned in the CEMP or else effluent to be discharged only on land after treatment for sprinkling or horticulture within the site. No discharge in the sea or any other receptor shall be undertaken until or unless permitted by the KSPCB.
- A303.9.4 Water Quality Monitoring: The Contractor shall engage a KSPCB/CPCB/MoEF & CC approved laboratory to undertake monitoring.
- A303.10 Noise Management
- A303.10.1 General Requirements
- 3.03.10.1.1 Installation and operation of Diesel Generator (DG) set shall comply with the guidelines of CPCB. DG Installation Certificate from Electrical Inspectorate shall be obtained.
- 3.03.10.1.2 Acoustic enclosures shall be provided to control noise levels. Necessary Acoustic enclosures or measures to control noise levels generated from the DG sets shall be installed by the Contractor as per Environment Protection Rules, 1986. In case DG set is manufactured before 2005, the Contractor shall ensure acoustic enclosure conforming to CPCB requirements.
- 3.03.10.1.3 Ambient noise levels should be strictly maintained within the standards by adopting appropriate techniques.
- 3.03.10.1.4 Exposure time of the workers to the higher noise level shall be reduced.

- 3.03.10.1.5 Steps shall be taken to control noise levels so as to maintain ambient air quality standard in respect of noise as laid down in Air (Prevention and Control of Pollution) Act, 1981. Regularly monitoring and maintaining DG sets (six monthly) shall be done and it shall be ensured that the noise level does not reach outside the site premises.
- 3.03.10.1.6 Regular preventive maintenance shall be undertaken and records maintained.
- A303.10.2 Noise Monitoring
- 3.03.10.2.1 Adequate measures shall be taken for control of noise levels below 85 dB(A) in the work environment.
- 3.03.10.2.2 Noise generated in the premises shall be within the prescribed limit 75 dB(A) during day and 70dB required during night time.
- 3.03.10.2.3 Ambient noise quality monitoring shall be carried out.
- 3.03.10.2.4 While installing any new DG set (manufactured after January 2005), the maximum permissible sound pressure shall be 75dB(A) at 1m from the enclosure surface.
- 3.03.10.2.5 Compliance with standards stipulated shall be followed for ambient noise.
- 3.03.10.2.6 Noise levels to be monitored between 06:00 a.m. and 10:00 p.m. for daytime and between 10:00 p.m. and 06:00 a.m. for night-time.
- 3.03.10.2.7 The Contractor shall ensure use of vehicles/ equipment with lessor noise pollution potential which shall include the following (but not be limited to) the following:
- (i) Construction techniques and machinery shall be selected to minimize noise.
 - (ii) The Contractor shall use equipment and vehicle that are in good working order, well maintained and have noise suppression equipment (e.g. Mufflers, noise baffles) in tact and in working order.
 - (iii) The noise level during pilling activity shall be kept minimum through proper lubrication, muffling, and modernization of equipment.
 - (iv) Construction vehicles to be used shall not emit noise greater than 90 dB (A) for eight hour operation shift.
- 3.03.10.2.8 The Contractor shall ensure that the siting of construction machinery/equipment shall comply with the following:

- (i) At construction sites within 150 m of human settlements, if any, noisy construction shall be stopped between 10:00 pm and 6:00 am.
- (ii) Noise producing sources such as the concrete mixers, generators, etc. shall be provided with noise shields around them. The noise shields can be any physical barriers, which provide adequate attenuation of noise levels.

A303.11 Waste Management (including hazardous waste)

A303.11.1 The Contractor shall implement procedures and processing to pursue a goal of “zero” waste discharge from his construction activities. This will require that the Contractor employ sustainable concepts and practices including recycling, re-use, segregation, and others to minimize, if not eliminate, material and substances into the waste stream. General Measures to include but not be limited to the following:

- (i) There shall not be any disposal of effluent/solid waste etc. into the sea.
- (ii) Solid waste shall be segregated from hazardous waste/municipal solid waste and stored separately till treatment/recycling, re-use.
- (iii) All solid waste generated from the construction and domestic activities shall be collected, treated and disposed in such a manner so as not to cause environment pollution.
- (iv) If no other use is identified for construction waste, it shall be dumped in selected pits, developed on infertile land, if approved by the Employer.
- (v) Solid Waste generated at sites are to be collected and processed for recycling/re-use wherever possible. Disposing it off landfill site should only be a last resort.
- (vi) Selection of disposal sites shall be carried out in consultation with KSPCB, revenue department and forest department in order to ensure that no natural drainage, productive lands or natural habitat is adversely impacted due to disposal of waste.
- (vii) Segregation of biodegradable and plastic wastes shall be done.

A303.12 Marine Environment Management

A303.12.1 Under no circumstances shall, materials including construction debris from the Works under the Contract, be allowed to pollute, or fall into any river, creek or the waters of the Cochin Port Trust/ Navigation Channels. All such material shall be promptly recovered and removed by the Contractor at no cost to the Employer. Floating debris within the site arising from any source shall be collected and disposed appropriately by the Contractor at regular intervals as agreed by the Employer. Floating debris shall be prevented from dispersing outside the Project Site limit.

- A303.13 The Contractor shall keep the Employer indemnified against the cost of any clean-up due to pollution of the marine environment or any Socio-economic and other aspects management.
- A303.13.1 No explosives shall be used in construction works. The Contractor shall develop management system as part of CEMP, which shall include:
- (i) Implementation and communication procedures.
 - (ii) procedure for submission of monthly report on number of complaints received, number of days of resolution, pending complaints and associated reasons for pendency.
- A303.13.2 During the construction phase, the proposed construction activity shall be notified by the Contractor, as per the direction of the Employer. Prior to commencement of construction activity, local residents and fishermen shall be advised about the installation, period of installation and associated activities.
- A303.13.3 Socio-economic aspects: The Contractor shall take into consideration the following socio-economic aspects:
- (i) Use of local labour to the maximum extent
 - (ii) Use of district hospital at Kochi for medical facilities.
 - (iii) Complaints received by locals or other evidence of illegal harvesting. Illegal wood/vegetation harvesting to be recorded.
 - (iv) Providing drinking water to workers,
 - (v) Providing personal hygiene and first aid facilities,
 - (vi) Preference to local villagers for non-skilled jobs subject to their willingness.
- A303.13.4 The Contractor shall ensure strict compliance of all applicable labour laws of centre/ state government by developing procedures (covering subcontractors also):
- (i) Provision of minimum wages for construction workers as per the Kerala State Government norms.
 - (ii) Ensure that the movement of fishing boats or fishermen communities shall not be disturbed during operation of the project.
- A303.14 Monitoring
- A303.14.1 Monitoring of aspects as detailed in this Document shall be undertaken.
- A303.14.2 The Contractor shall develop a detailed monitoring plan as part of CEMP and the guidelines of MoEF&CC.
- A303.14.3 All the equipment utilized for monitoring shall be duly calibrated as per approved QA Plan of the Contractor.

A303.14.4 Monitoring standards to be followed are detailed under detailed Standards and Formats of Reporting. The Contractor shall ensure that for monitoring parameters, where national/ regional/ local regulatory requirements are silent, and compliance with the baseline values as detailed in the EIA undertaken for the Project are compared. Compliance shall be determined for such aspects based on baseline changes.

A303.15 Organisation Structure

A303.15.1 The Contractor shall ensure appointment of competent Environmental Officer(s), who shall work in coordination with Employer, and his staff, for effective environment management and implementation of CEMP.

A303.15.2 The Environmental Officer(s) shall be responsible for:

- (i) Preparing CEMP specific to work type and submit to the Employer for review prior to commencement of work;
- (ii) Ensuring compliance with regulatory framework and best practices as identified in the CEMP;
- (iii) Obtaining all pertinent environmental permits and approvals prior to commencement of work onsite after due approvals from Employer;
- (iv) Conduct continual checks for validity of environmental permits and approvals and obtain necessary extension(s) in advance so as to ensure smooth flow of work;
- (v) Ensure compliance with environmental monitoring as prescribed in Annexure-Check off list, assess data, maintain records and generate timely reports for further submission to the Employer;
- (vi) Conduct regular checks for compliance against management measures and address environmental concerns onsite. Additionally, report any noncompliance to the Employer;
- (vii) Provide training to working staff and initiate sensitization sessions on environment practices to be followed onsite for effective environment management; and
- (viii) Inscribe corrective action measures into existing environment management structure and ensure compliance to the same with approval from the Employer.
- (ix) Actively participate in Environment Management Cell meetings and provide status of implementation of Construction Environment Management Plan, associated monitoring activities, difficulties/ issues in implementation, other aspects of importance, etc.
- (x) Working with and through the Employer, liaise with Kerala State Pollution Control Board, District Collector and other agencies on all matters concerning pollution affecting establishments and units.
- (xi) Coordinate activities towards award of environment protection incentives.

- (xii) Meet regularly with the Employer, and/or his staff, and Employer as requested. The Employer shall organize regular coordination meetings for passing of information, reporting of issues, review of current and upcoming events, status of open issues, coordination and reporting of environmental concerns, reports, notices, etc. and other matters relating to the Project and environmental aspects of the same.
- (xiii) Adequate funds shall be earmarked for implementing Environment Management Plan in a time-bound manner. The budget allocated shall not be diverted for any other purpose. Capex earmarked for implementation of CEMP shall be submitted as part of six monthly reports for review to Employer.

A303.15.3 He/she shall be fully familiar with pertinent safety requirements and policy as contained in statutory requirements, the Employer HSE Plan, the Contractor's HSE Plan, and any other regulatory document pertaining to safety in the workplace in India.

A400 QUALITY MANAGEMENT

A401 QUALITY MANAGEMENT PROGRAM REQUIREMENTS

A401.1 The Contractor shall be responsible for all quality management in the planning and execution of the Works. The quality management shall cover all stages of work such as setting out, selection of materials, selection of construction methods, selection of equipment and plant, deployment of personnel and supervisory staff, quality control testing, etc.

A401.1.1 The Contractor shall be responsible for the following work under the quality provisions of this Contract:

- (a) Implementing their corporate Quality Management System and providing evidence of third party assessment and endorsement;
- (b) Developing and implementing an effective and comprehensive Project Quality Plan (PQP) to cover all Works under the Contract, whether permanent or temporary both on-site and off-site;
- (c) This PQP shall be submitted to “The Employer” for his/her review and approval prior to using in the contracted Works. The Contractor shall make changes and adjustments to the PQP as recommended by the Employer.
- (d) Operating, maintaining and reviewing the Project Quality Plan and associated quality management system procedures; and
- (e) Keeping Quality Records in accordance with Project Quality Plan.

A402 PROJECT QUALITY PLAN

A402.1 The Contractor shall prepare a project specific Project Quality Plan in line with his Corporate Quality System. The PQP shall be Contract-specific and shall include specific quality practices, resources, activities and responsibilities relevant to the Contract Works.

A402.2 The Contractor shall submit the PQP to the Employer within 45 days of the Contract Commencement Date or at least 14 days prior to the intended commencement of any permanent Works under the Contract, whichever is earlier. The Employer will take maximum 7 days for issuing comments (if any) to be incorporated by the Contractor.

A402.3 The resolution of such comments on the PQP submission to the satisfaction of the Employer and the subsequent acceptance of the PQP by the Employer shall constitute a Hold Point on the commencement of any permanent Works under the Contract.

A402.4 System Element Procedures

A402.4.1 Quality System Procedures shall be prepared to meet the requirements of Employer's Quality Plan. These Procedures and Instructions shall be submitted to the Employer for approval 14 days prior to the commencement of the relevant activity.

A402.5 Hold Points & Witness Points

A402.5.1 Hold Points are those points beyond which the work may not proceed without review and comment by the Employer.

A402.5.2 Witness Points are those points beyond which the work may not proceed without approval of the Employer.

A402.5.3 As a minimum requirement, the specified Hold Points shall be included in the Inspection and Test Plans where identified in the technical Clauses of the Specification by the words “to the approval of the Employer”, “Employer for Approval”, “and “agreement of the Employer” or similar.

A402.5.4 The Employer may nominate additional Witness and Hold Points in the Contractor's Inspection and Test Plans.

A402.5.5 Where Hold Points are nominated, no work shall proceed unless agreed by the Employer.

A402.5.6 For avoidance of doubt, the review by the Employer of any Hold Point or Witness Point will not relieve the Contractor of any responsibility for the satisfactory execution or performance of the work that is the subject of the review.

A402.6 Documentation

A402.6.1 In addition to the documentation required by ISO 9001, copies of all relevant Codes of Practice, Test Methods and Standards referred shall be kept on Site.

A402.7 Inspection and Test Plans (ITPs)

A402.7.1 Inspection and Test Plans (ITP's) shall be prepared for each of all on- site and off-site construction activities/processes for which the Contract requires inspections of test to be performed. ITPs shall describe all inspections and tests required, the criteria for acceptance and the person in charge and responsible for each inspection or test. ITPs shall note any Hold Points or Witness Points that require the Employer's approval or presence.

A402.7.2 Proforma ITPs shall be submitted to the Employer for review and approval within 14 days (unless specified otherwise) before the subject operation/activity is first undertaken. Operations which are subject to inspection or test shall not commence until the relevant ITP is accepted by the Employer.

A402.7.3 The ITPs shall cover all inspection and testing required by the Contract and shall include surveying and measuring verification processes, as well as sampling procedures. All quality control laboratory tests shall be performed in accordance with the relevant Indian or other standards approved in writing by the Employer for the relevant test. Test reports shall be certified by an approved signatory.

- A402.7.4 The ITPs shall clearly state the times within which each activity will be completed. All test reports shall be made available immediately on its receipt. Failure to produce satisfactory test reports within the specified time may be considered to demonstrate that the work to which the test report relates is unsatisfactory, and remedial work may be ordered to be undertaken forthwith.
- A402.8 Sampling and Testing
- A402.8.1 All sampling and testing required by the Contract or instructed by the Employer shall be carried out only by such independent commercial testing facilities as may be approved by the Employer.
- A402.8.2 The Contractor shall submit to the Employer the name(s) of the independent commercial testing facilities that are proposed. The submission shall contain such data as is necessary to fully demonstrate to the Employer that (each) such testing facility is adequately equipped, supervised and staffed and has relevant previous experience. The testing facility shall obtain the accreditation from the National Accreditation Board for Testing and Calibration Laboratories (NABL) for the relevant tests unless otherwise approved by the Employer, and where appropriate, shall be on a list approved by the relevant Authorities. The Contractor's submission shall also include the lists of sampling and tests proposed to be undertaken by the testing facility (or facilities) together with a statement for each test regarding whether it is to be executed at the testing facility or elsewhere (including on Site). In the latter case, and for all sampling, attendance of personnel from the testing facility shall be provided during the sampling and/or execution of the test. Once any testing facility has been approved in writing by the Employer, it shall be appointed by the Contractor and then will be termed an Approved Laboratory for the tests listed within such approval.
- A402.8.3 The Contractor may propose to undertake testing at the Field Laboratory on Site, provided these meet all the above requirements, and in particular that the testing facility is operated, managed and staffed by independent commercial testing company. Should the Employer at any time be dissatisfied with the quality of testing carried out at the testing facilities established on Site, he may require such tests to be performed at a permanent independent commercial testing facility away from the Site until such time as the Contractor can demonstrate to the Employer's satisfaction that the necessary improvements have been made at the testing facilities on Site.
- A402.8.4 Should the Contractor have reasonable cause to change testing facilities, he may propose an acceptable alternative to the Employer. Should the Employer at any time have reasonable cause to be dissatisfied with the performance of any Approved Laboratory, he will so inform the Contractor who shall propose an acceptable alternative independent testing facility. In either case, after receiving written approval of the new testing facility (and upon completion of any test or series of tests already committed) the Contractor shall make the necessary change in appointment. Costs, if any, of or associated with any such change shall be borne by the Contractor.

- A402.8.5 The management of each Approved Laboratory shall nominate in writing the person or persons who are authorised by them to sign test reports, and a copy of this authorisation shall be sent to the Employer. No test report shall be accepted by the Employer as valid without the signature of a person whom the Employer has been informed in writing, is so authorised to sign test reports from that Approved Laboratory.
- A402.8.6 Where tests or other samples are required to be made, prepared or selected, such work as is necessary to cut or otherwise make or prepare the selected specimen(s) shall be executed by the Contractor under the supervision of the Approved Laboratory unless specifically agreed otherwise by the Employer. If any test or sample preparation, making or selection proceeds without such supervision they shall not be accepted and the work re-executed. The Employer shall be notified prior to the carrying out of such work so that he can be present. The Employer may also instruct that the Contractor carry out additional sampling or testing in order to verify that the requirements of the Contract are being met.
- A402.8.7 The Employer shall reserve the right to carry out his own independent sampling and testing for the purposes of cross-checking and verification of the Contractor's sampling and testing. The Contractor shall provide all reasonable access to the Works for the Employer to carry out such independent sampling and testing. Where the findings of the Employer's independent sampling and testing indicate a non-conformance with the Contract Requirements, the Contractor shall immediately raise a Non-Conformance Report covering the work represented by the non-conforming results.
- A402.8.8 Any additional sampling or testing related to replacement of damaged or lost samples, to the methods of working or construction, to previously failed tests or any other cause whatsoever, shall be executed by an Approved Laboratory.
- A402.8.9 The Contractor shall clearly identify methods of sampling and testing and the party or parties responsible in the ITPs for the relevant construction activity.
- A402.9 Storage of Samples
- A402.9.1 Where samples are required by the Contract, the Contractor shall provide and maintain a suitable facility or facilities to temporarily store such samples on Site. The samples shall be kept as long as the Employer requires, and then taken to an Approved Laboratory for testing and/or disposed of, by the Contractor.
- A402.10 Inspection
- A402.10.1 The Contractor shall provide the Employer with access to all laboratories and other facilities used for quality control tests such that it can be verified that the specified requirements are being met.

A402.11 Identification and Traceability

A402.11.1 All test samples shall be marked with a unique reference and in a manner such that the reference will not be erased or otherwise lost prior to testing. Should it not be appropriate for the samples to be immediately collected by the Approved Laboratory, the Contractor shall deliver them to an approved sample store(s) on Site. Such sample store(s) shall be provided and maintained by the Contractor. The Contractor shall provide and maintain within the sample store(s), all necessary racks and/or equipment and keep them in good repair.

A402.11.2 All quality records shall be traceable from the Inspection and Test Procedures to the deliverable set.

A402.12 Records

A402.12.1 The Contractor shall generate quality records covering all construction / execution activities.

A402.12.2 Conformance records shall be stored and maintained such that they are readily retrievable in facilities that provide a suitable environment to minimise deterioration or damage, and to prevent loss. Records shall be retained progressively and handed over completely, within four weeks of the issue of the Taking-over Certificate for the completed Works.

A402.12.3 Conformance records shall be available at all reasonable times, and copies provided within 24 hours of receipt of the test results.

A402.13 Non-conformance

A402.13.1 The Contractor shall notify the Employer of any product or service non-conformance. Notification shall be submitted as Non-Conformance Reports (NCR) and shall indicate the proposed method of rectification and shall be subject to acceptance by the Employer. Additionally, the Employer may require the Contractor to raise an NCR for any work that is in the opinion of the Employer not in conformance to the requirements of the Contract. The Contractor shall prepare Standard forms for use as Non-Conformance Reports; the format of these forms shall be agreed with the Employer prior to the Works.

A402.13.2 Work which is the subject of a Non-conformance Report shall not be covered prior to inspection and agreement with the Employer.

A402.14 Surveillance and Audit

A402.14.1 The Employer, or his representative, shall carry out Quality Surveillance and Audits (scheduled and unscheduled) to ensure conformance to the requirements of the Contract. These will involve system element audits, product and service audits, and process and technical procedure audits.

- A402.14.2 The audits to be undertaken will be in addition to the Contractor's audits and will not relieve the Contractor of its responsibilities under the Contract. The Employer will carry out audits in accordance with ISO 19011:2011 at times to be determined by the Employer. The Contractor will be given at least five (05) days' notice that a quality audit is to be carried out. The Contractor shall provide or arrange to be available all necessary facilities, documents etc. including SubContractors etc. for audits.
- A402.15 SubContractors
- A402.15.1 The Contractor shall be fully responsible for integrating all SubContractors' Quality Systems into its own Quality System or alternatively for arranging for the SubContractor to work within a Quality system developed and provided by the Contractor.
- A402.15.2 The Contractor shall be the single point of responsibility for the production, implementation and auditing of the Quality System required under the Contract.

A500 TEMPORARY FACILITIES AND CONTROLS

A501 CONTRACTOR'S SITE ESTABLISHMENT PLAN

- A501.1 The Contractor shall submit his own Site Establishment Plan to the Employer for approval at least seven (07) days prior to the commencement of any site establishment, temporary or any other Works under the Contract.
- A501.2 This submission shall include confirmation of the Contractor's intended date for the commencement of site establishment and any other site work.
- A501.3 The Contractor's Site Establishment Plan shall include details of the proposed facilities including but not limited to the following items:
- (a) General layout of site fencing (8 m high fencing), site access points, stacking and storage of construction material, other security arrangements;
 - (b) General layout of construction facilities including the Contractor's field offices, sheds, sanitary and first aid facilities, Field Laboratory and CoPT's and IN's offices;
 - (c) Details of arrangements for emergency access/egress and evacuation points;
 - (d) General layout of work areas, casting yards, crushing yard, fabrication or coating workshops, if Contractor's Work Plan defines onshore casting/crushing/fabrication/coating;
 - (e) Dust protection measures from adjacent bulk stockpiles of materials; and ;
 - (f) All other details relating to the site establishment as required under the Contract or by any relevant authority.
- A501.4 The approval of the Site Establishment Plan by the Employer shall constitute a Hold Point on the commencement of site establishment, temporary or any other Works under the Contract.
- A501.5 Labour camp, any batching plant and stone crushing plant are not allowed inside the Project Site and Naval area.
- A501.6 Any request by the Contractor to change the agreed proposals shall be subject to the agreement of the Employer.

A502 TEMPORARY UTILITIES

- A502.1 It is the responsibility of the Contractor to arrange and obtain permission from the relevant Authorities for the installation, connection and disconnection of temporary services and utilities such as power, water, and any other services the Contractor deems necessary to execute the Works. The Contractor shall be responsible for all costs associated with the supply of these services.

- A502.2 The Contractor shall install, maintain and pay for such services like water and power and any other facility/service required for the construction of Works. The Contractor shall lay cables/pipelines from nearest connection points up to the Site at his own cost. In case of the realignment of utilities due to the construction constraints, the same shall be carried out by the Contractor at this own cost and nothing extra shall be payable on this account.
- A502.3 The Employer / IN at its own discretion may provide LT power supply and drinking water provision (for running offices), at one location near the vicinity of the Project Site, which are chargeable as per MES rates. The Contractor shall arrange to have suitable metering devices towards quantifying consumption.
- A502.4 The Contractor shall install and maintain CCTV arrangements at the Project Site including the Construction Site, Storage areas, casting yard, fabrication yard etc.
- A502.5 All temporary services shall be removed and made good on completion of the Works, as per the directions of the Employer.

A503 CONSTRUCTION FACILITIES

- A503.1 Contractor's Site Compound
- A503.1.1 The entire Contractor's Site Compound (with 8 m high fencing) including Contractor's site offices, sanitary and first aid facilities, car parking, field laboratory, security facilities, Employer's and IN's Field Offices and the like shall be confined within the area designated for the Contractor's site establishment as instructed by the Employer.
- A503.1.2 The Contractor shall take all necessary measures to reduce dust from adjacent areas, including from bulk stockpiles and crushing yard by means of barriers or other suitable systems. Special precautions are to be taken during the monsoon period taking into account the prevailing wind directions.
- A503.1.3 The Contractor shall submit the proposed location and layout of the Contractor's Site Compound to the Employer for approval as part of his Site Establishment Plan.
- A503.2 Sanitary Facilities
- A503.2.1 The Contractor shall provide and maintain to the satisfaction of the Employer, sufficient sanitary facilities and ablutions for all personnel engaged on the Works who shall use these provided facilities exclusively. The Contractor shall be responsible for arranging for the proposed handling and disposal of sewage from the site and for obtaining all required permissions from the relevant authorities.
- A503.2.2 No sewage or effluent shall be discharged into any river, creek, backwaters or the waters of the sea or navigation channels. Sewage should be treated so as to achieve the required standards prescribed by the applicable regulatory agencies and reused/recycled within the Works to the extent feasible.
- A503.3 Provision of Field Laboratory

- A503.3.1 The Contractor shall submit the details of the Site Laboratory to be set up by him for the successful completion of the Work. The Contractor shall obtain the approval of Employer prior to commencement of such laboratory set up.
- A503.3.2 The laboratory shall be equipped with the required testing equipment. The testing equipment shall be calibrated as per QA Plan of the Contractor.
- A503.3.3 The Contractor is encouraged to use the approved construction material testing laboratories located in Kochi for fulfilling the testing requirements on day to day basis required under the Contract for site control on the quality of materials and the Works. In case the contractor sets up his own laboratory at site it shall meet the requirements as mentioned in Clause 503.5.6.
- A503.3.4 The Contractor shall be responsible for all aspects of maintenance and operation of the Laboratories, including all associated costs with purchase, delivery, erection, calibration of equipment, operation, including sampling, storage, curing and testing of materials, periodic re-calibration of equipment, supply of consumables, recording and submitting test results to the Employer and removal on completion of the Works.
- A503.3.5 The field laboratory shall be provided with equipment including but not limited to the following:

5.03.3.5.1 General:

(a)	Oven - Electrically operated, thermostatically controlled range upto 200 °C sensitivity 1°C	1 No.
(b)	Platform balance 300 kg capacity	1 No.
(c)	Balance 20 kg capacity- self indicating type	1 No.
(d)	Electronic Balance 5 kg capacity accuracy 0.5 gm	1 No.
(e)	Water bath - electrically operated and thermostatically controlled with adjustable shelves, sensitivity 1°C	1 No.
(f)	Thermometers: Mercury-in-glass thermometer range 0°C to 250°C Mercury-in-steel thermometer with 30cm stem, range upto 300°C	2 Nos.
(g)	Gas stove or electric hot plate	1 No.
(h)	Glassware, spatulas, wire gauzes, steel scales, measuring tape, casseroles, karahis, enameled trays of assorted sizes, pestle-mortar, porcelain dishes, gunny bags, plastic bags, chemicals, digging tools	As required

	like pickaxes, shovels etc.	
(i)	Set of IS sieves with lid and pan: 450mm diameter: 106mm, 75.0mm, 63mm, 53mm, 37.5mm, 26.5mm, 19.0mm, 13.2mm, 9.5mm, 6.7mm, and 4.75mm size 200mm diameter: 2.36mm, 2.0mm, 1.18mm, 600 micron, 425 micron, 300 micron, 150 micron, and 75 micron	1 set 1 set
(j)	Water testing kit	1 set
(k)	First aid box	1 set
(l)	GPS set	2 sets

5.03.3.5.2 For soils and stones:

(a)	Riffle Box	1 No.
(b)	Atterberg Limits (liquid and plastic limits) determination Apparatus	1 set
(c)	Compaction Test Equipment both 2.5 kg and 4.5 kg rammers (Light and Heavy compactive efforts)	1 set
(d)	Dry Bulk Density Test apparatus (sand pouring cylinder, tray, can etc.) complete	1 set
(e)	Speedy Moisture Meter complete with chemicals	1 set
(f)	Post-hole Auger with extensions	1 set
(g)	Core cutter apparatus 10 cm dia, 10/15 cm height, complete with dolly, rammer etc.	1 set
(h)	Aggregate Impact Value Test apparatus/Los Angeles Abrasion Test apparatus	1 set
(i)	Flakiness and Elongation Test Gauges	1 set
(j)	Standard measures of 30, 15 and 3 liters capacity along with standard tamping rod	1 set

(k)	California Bearing Ratio test apparatus	1 set
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5.03.3.5.3 For Cement & Cement Concrete:

(a)	Vicat apparatus for testing setting times	1 Set
(b)	Slump testing apparatus	2 sets
(c)	Compression and Flexural strength testing machine of 200 ton capacity with additional dial for flexural testing	1 No.
(d)	Needle Vibrator	2 Sets
(e)	Air Meter	1 No.

A503.4 Provision of Employer's Office

A503.4.1 The Contractor shall provide and maintain a separate fully furnished and air-conditioned office accommodation for the sole use of the Employer and the supervisory staff of the Employer. The Employer's Office shall be located in such a location and position as directed by the Employer.

A503.4.2 The Contractor shall provide the specified Employer's Office (fully furnished and operational) within 3 (Three) months of the Contract Commencement Date.

A503.4.3 The complete establishment of the Employer's Office to be provided by the Contractor to the satisfaction of the Employer shall constitute a Hold Point on the commencement of any permanent Works on site under the Contract. The Employer's Office shall be provided and maintained until 28 days after the issue of the Taking-Over Certificate for the complete Works.

A503.4.4 The Employer's Office shall accommodate 20 people and shall consist of:

- 5 office rooms (3 for CoPT and 2 for Navy) each with a floor area of at least 9m²;
- Cubicle space to accommodate 17 people with a floor area of at least 90 m² total with provision for printing facilities;
- 1 discussion room with a floor area of at least 32 m² for CoPT/ Indian Navy with provision of printing facilities and storage.
- 1 fire-proof store rooms with a floor area of at least 10m² with suitable stacks;
- 01 server room with a floor area of at least 10m² with all necessary connections;
- Washroom for women with at least one basin and one WC;

(g) Washroom for men with at least three basins, three urinals and 3 WCs;

A503.4.5 The areas above are exclusive of wall thickness, services provisions, printing facilities and circulation areas. All latest applicable codal provisions for fire and safety are to be provisioned for. The office shall be of construction and design suitable for prevailing climatic conditions. The containers or porta cabins can be used for making office space.

A503.4.6 The office shall be provided with all plumbing, water services, drains, all electrical items like lights and complete wiring(including internet network), providing water supply including all pipes, fittings, tanks, pumps, valves etc. complete, septic tank, sewer lines, equipment, furniture, furnishing (including waste disposal) and the like, completely finished and ready for occupation including consumable items for pre-fabricated unit(s). It also includes replacement of any item provided in this Section.

A503.4.7 The Employer's Office shall be properly ventilated and proofed against weather, water ingress, insects and termites. Each room shall be fitted with a false ceiling and the space between the roof and the ceiling shall be properly ventilated. The minimum headroom shall be 2.7 m.

A503.4.8 All areas should be adequately networked for telephone and internet connections.

A503.4.9 List of minimum furniture to be provided and maintained for Employer's Office shall be as shown in table below:

S. No.	Description	Qty.
1.	Executive desk with two lockable drawers and chair (swivel with leather upholstery)	5 Nos.
2.	Cubicle furniture with two lockable drawers and chairs (swivel with cloth upholstery)	17 Nos.
3.	Mobile connection with smartphone handset	20 Nos.
4.	A3heavy duty laser colour printer/copier/scanner with network facility	01 No.
5.	A4 heavy duty laser colour printer/copier/scanner with network facility	02 Nos.
6.	A3 heavy duty photocopier with network facility	01 No.
7.	Document shelves/stacks	08 Nos.
8.	Visitors Chairs(swivel with cloth upholstery)	20 Nos.
9.	Drawing Rack	12 Nos.
10.	Bulletin Boards (1.2m X 2m)	03 Nos.
11.	White Boards (1.2m X 2m)	04 Nos.

S. No.	Description	Qty.
12.	Safety helmets and reflective vests	25 Nos.
13.	Safety Shoes of various sizes	25 Nos.
14.	Conference table with 12 chairs	01 No.
15.	LED projector with screen	01 No.
16.	Laptops (Dell or HP or equivalent & i5 or higher processor with 1 TB hard disk and 6 GB or more ram) preinstalled with all required applications	04 Nos.
17.	Desktop (Dell or HP or equivalent & i5 or higher processor with 1 TB hard disk and 6 GB or more ram) preinstalled with all required applications	01 No.

A503.4.10 The Contractor shall arrange to provide uninterrupted supply of electricity and water for the office building. In case of failure of main power/water supply, alternative source shall be available for providing uninterrupted supply.

A503.4.11 The Contractor shall undertake maintenance of the Employer's Office throughout the Works including the day to day upkeep of the building and the surroundings, attending to repairs to various parts of the building, furniture, fittings, office equipment and the connected services as and when necessary, periodic white/colour washing of the building and painting of wood work, steel work, replacing the broken window/door/ventilator glasses, furniture and other hardware and maintaining necessary watch and ward during day and night.

A503.4.12 Upon completion of the works and before handing over, the Contractor shall remove the Employer's Office from site.

A503.5 Assistance to the Employer

A503.5.1 The Contractor shall allow for the provision of labourers to assist the Employer, if and when required throughout the Works.

A503.5.2 The Contractor shall provide one (01) Workboat in good condition for the exclusive use of the Employer or his representative for inspection of marine Works.

A503.5.3 The Contractor shall provide suitably qualified boatmen responsible for the operation and maintenance of the Workboat.

A503.5.4 The Workboat shall be capable of carrying at least six (06) passengers in addition to crew required for the operation of the Workboat and shall be equipped with a rain shelter providing standing headroom for at least six (06) passengers.

- A503.5.5 The Workboat shall be equipped with an engine of sufficient capacity to give a safe speed of at least 6 knots under all anticipated sea states. The Workboat shall be provided with sufficient numbers of life jackets for the full complement of crew and passengers as well as any other safety equipment as may be required under the prevailing local, port and Contractors site regulations.
- A503.5.6 The proposed layout of the Workboat shall be subject to the approval of the Employer.
- A503.5.7 The Contractor shall provide the specified Employer's Workboat within 28 days of the Contract Commencement Date or at least 7 days prior to the commencement of any marine Works under the Contract, whichever is earlier. The Workboat shall be provided and maintained until 28 days after the issue of the Taking-Over Certificate for the complete Works.
- A503.5.8 The Employer's Workboat shall be licensed under the relevant statutory requirements and shall be manned and maintained in good seaworthy condition.
- A503.5.9 All expenses required for keeping the Workboat in smooth running condition such as fuel, lubrication oil and other consumables, necessary service and maintenance, crew, repairs and replacement etc. shall be met by the Contractor.
- A503.5.10 The Contractor shall provide and maintain three (03) numbers (2 for CoPT and 1 for Navy) four wheeled drive, air-conditioned new vehicles (Mahindra XUV500 make or equivalent), to accommodate 5-6 people each, and for the exclusive use of the Employer.
- A503.5.11 All vehicles shall be equipped with fire extinguisher and first aid kits. The vehicles shall be fitted with seatbelts for the driver and all passengers as well as any other safety equipment as may be required under the prevailing local, port and Contractor's site regulations.
- A503.5.12 The proposed make, model and condition of the vehicles shall be subject to the approval of the Employer.
- A503.5.13 The Contractor shall provide the specified Employer's Vehicles within 28 days of the Contract Commencement Date or at least 07 days prior to the commencement of any site establishment, temporary Works or any other site Works under the Contract, whichever is earlier. The vehicles shall be provided and maintained until 28 days after the issue of the Taking-Over Certificate for the complete Works.
- A503.5.14 A vehicle shall be replaced with a new vehicle after its maximum run of 100,000 km or five years of manufacture, whichever is earlier. All necessary taxes for operating the vehicles shall be fully paid and all necessary papers shall be provided as required by prevailing Motor Vehicles Act with comprehensive insurance cover for the vehicles. The Contractor shall also make available drivers having valid license at such times and for such duration as instructed by the Employer.

- A503.5.15 The vehicles shall be maintained in a smooth running condition. All expenses required for keeping the vehicles in smooth running condition such as fuel, lubrication oil and other consumables, necessary service and maintenance, drivers, repairs and replacement etc. shall be met by the Contractor. In the event of any vehicle being off the road for maintenance or on account of breakdown, the Contractor shall provide equivalent substitute vehicle(s) immediately.
- A503.5.16 If the Contract Works are not completed within the stipulated period or within the granted extended time of completion, provision and maintenance of vehicles shall be carried out by the Contractor at his own cost and no payment shall be made for the same.
- A503.5.17 The Contractor shall provide and maintain Personal Protective equipment (PPE) as may be required by the Employer for inspection of the works.
- A503.6 Provision for Security Operation
- A503.6.1 The Contractor shall be responsible for physical security of the assets and persons at his Work Site. The security personnel deployment shall be carried out based on the requirement. The security posture shall consist of security processes, guarding manpower and technology control which shall be decided in consultation with the Employer.
- A503.6.2 The security guards shall be deployed at a calculation of 2% of the total work force of the Contractor for managing security operation of the Work Site. All compliances need for manpower deployment shall be followed by the Contractor. All supervisory control shall remain with the Employer.

A504 CONTRACTOR'S SITE ACCESS MANAGEMENT PLAN

- A504.1.1 The Contractor shall submit his Site Access Management Plan to the Employer for approval at least 07 days prior to the commencement of any site establishment, temporary or any other Works under the Contract. The Contractor shall follow the overall Project Site Management Plan. Contractor's Site Access Management Plan will be reviewed and approved by the Employer.
- A504.1.2 The Contractor's Site Access Management Plan shall include figures or drawings and accompanying notes detailing the proposed site traffic management Works (subject to the further requirements of this section of the Specification) including but not limited to the following items:
- (a) General methodology and route for accessing Site;
 - (b) Arrangement and approximate timing for the delivery of materials and equipment throughout the course of the Works as well as any special arrangements or controls for mobilisation of oversize plant or delivery of oversize equipment;
 - (c) Labour timing;
 - (d) Proposed internal construction traffic controls (signage, line-marking, signals etc.) both for internal site roads and at interfaces with existing external roads;

- (e) Any proposed temporary traffic controls for existing external roads that may be necessary from time to time to facilitate delivery of materials or equipment to site or any other Works on such roads; and
- (f) Arrangement for marine access to marine construction work and Site Portions including navigational arrangement, temporary aids to navigation, anchoring and mooring arrangement.

- A504.1.3 The Contractor shall prepare the Site Access Management Plan with a view to minimizing interference with existing traffic (both landside road traffic and marine traffic and shipping) to and from the existing facilities in the vicinity of the site. All vehicles or marine craft using the existing public roads/ waters external to the site shall comply with the prevailing local and port rules and regulations as well as the requirements of any other relevant authorities.
- A504.1.4 The Site Access Management Plan shall identify such facilities as are necessary to ensure that construction dust and debris is not carried onto the existing port/Naval roads, thoroughfares or adjoining properties by vehicles leaving the site. Any damage or disturbance caused by vehicles leaving the site shall be rectified immediately by the Contractor to the satisfaction of the Employer.
- A504.1.5 The approval of the Site Access Management Plan by the Employer shall constitute a Hold Point on the commencement of site establishment, temporary or any other Site Works under the Contract as well as mobilization of plant and delivery of any materials or equipment to the site.
- A504.1.6 Any request by the Contractor to change the agreed proposals shall be subject to the agreement of the Employer.
- A504.2 Following shall be considered regarding the access to Project Site:
- (a) Security clearances: Security clearances for personnel, vehicles, equipment for entry into Naval premises shall be provided by Indian Navy (IN) on best effort basis. Details of manpower to be employed shall be provided to IN atleast six working days in advance. Application shall include complete details of personnel, photographs, UID No., permanent address, contact numbers and shall mandatorily contain police verification certificates. IN shall have the right to undertake photography of personnel employed and undertake physical/electronic search / frisking of body and equipment / materials / cargo.
 - (b) Security against Items or Damage: The Contractor shall be responsible for safety of his stores / items / works. The Employer / IN will not be responsible for the Contractor's stores / items / works.

- (c) Entry / Exit: The entry / exit shall be as per the existing provisions in force and as amended from time to time. The gates for entry / exit will be specified by the Station Commander. A separate register shall be implemented / maintained by the Contractor for movement of personnel and materials at the security gates. The data should be made available to the Employer / IN on a regular basis. The Project Site including Contractor's Work Area shall be fenced with 8 m dust proof protection with gates for access to IN.
- (d) Identity Cards or Passes: The issuance of passes for personnel would be as per the existing provisions, as amended from time to time.

A505 TEMPORARY BARRIERS AND ENCLOSURES

- A505.1 The Contractor shall maintain fencing, employ watchmen and any other measures necessary so as to maintain the security of the Field Office, Work Site, and all other facilities related with this Contract, at all times pursuant to the requirements of Clause 4.22 of the Conditions of Contract.
- A505.2 Temporary fencing shall be installed and maintained by the Contractor for the security of plant, equipment and materials used in connection with the Works.
- A505.3 The temporary fence shall be completed as soon as practical following initial Possession of the Site and removed immediately prior to issue of the Taking-Over Certificate for the Works (or part thereof).
- A505.4 It remains the responsibility of the Contractor to establish the type of fencing that the Contractor requires to separate the construction area from public areas, other sites and port/Naval operational areas and to provide the level of site security/safety the Contractor deems necessary for the site and work areas. A view cutter of 8m height is required to be installed on the periphery of the work areas.
- A505.5 Construction work shall be confined to areas within the fenced construction site area except with the written approval of the Employer.

A506 PROJECT INFORMATION SIGN BOARD

- A506.1 The Contractor shall erect two signboards at prominent locations on the Site to identify the site to occasional visitors. The size, layout and location of the signboards shall be agreed with the Employer.
- A506.2 The Contractor shall not erect within or near the site or elsewhere on the Employer's/Naval land any sign or notice board without prior approval, except safety signs.
- A506.3 The Contractor shall dismantle, remove and dispose of all such signs off site upon issue of the Taking-Over Certificate for the Works.

A600 PRODUCT/ MATERIALS REQUIREMENTS

A601 COMMON REQUIREMENTS

A601.1 General

A601.1.1 Materials to be used in the Work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these Specifications.

A601.1.2 Only new products, materials or equipment shall be supplied for use in the permanent Works. Pre-owned or pre-used products, materials or equipment shall not be supplied unless specifically accepted in writing by the Employer.

A601.1.3 Products, materials and equipment to be incorporated in the permanent Works shall not be used in any temporary Works prior to their incorporation into the permanent Works unless specifically accepted in writing by the Employer.

A601.1.4 If any material, not covered in these Specifications, is required to be used in the Work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Employer.

A601.2 Approval of Manufacturers and Suppliers

A601.2.1 The Contractor shall submit details of the proposed source, manufacturer or supplier of all products, materials or equipment to be used in the permanent Works to the Employer for approval. The details to be submitted by the Contractor shall include but not be limited to the following: ;

- (a) Name of the product, material or equipment to which the submission relates including reference to relevant sections of the Contract Documents;
- (b) Name of the proposed source, manufacturer or supplier; Certificates, test results or any other information or evidence demonstrating that the proposed product, material or equipment confirms to the requirements of the Contract;
- (c) Declaration that the product, material or equipment shall be supplied in accordance with the requirements of the Contract including all specified markings and certificates;
- (d) Instructions or directions for the handling, storage or usage of the product, material or equipment from the source, manufacturer or supplier;
- (e) Any other relevant technical details as may be required under the Contract or by the Employer.

- A601.3 The Contractor shall submit such details to the Employer for approval at least 14 days prior to placing orders for the subject product, materials or equipment. The approval of the submission by the Employer shall constitute a Hold Point on the delivery of the subject product, materials or equipment to site. Irrespective of any such approval, the Contractor shall remain responsible for the quality and conformance of the subject product, material or equipment to the requirements of the Contract.
- A601.4 Once approved, sources shall not be changed without the written approval of the Employer. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from other sources at his own expense.
- A601.5 Samples
- A601.5.1 Where required by the Employer, the Contractor shall at his own expense, submit to the Employer for approval, samples of any of the materials and components to be used in the Contract Works. The quality of materials and components to be used in the Works shall not be inferior to the approved samples.
- A601.5.2 Aggregates from the quarries shall be submitted by the Contractor to the Employer at no extra cost.
- A601.5.3 Samples provided to the Employer or his representative for their retention are to be in labelled boxes suitable for storage.
- A601.5.4 Samples required for approval and testing must be supplied well in advance at least 48 hours or minimum period required for carrying out relevant tests to allow for testing and approval. Delay to Works arising from the late submission of samples will not be acceptable as a reason for delay in the completion of the Works.
- A601.5.5 If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall have to be borne by the Contractor.
- A601.6 Alternatives or Equivalentents
- A601.6.1 In all cases where the name of a particular type or make of material, product, equipment or item is referred to in the Contract, this indicates the minimum acceptable standard. The Contractor may offer equipment or materials other than those specified and in all such cases, the Contractor's offer shall be of at least equal quality. The same shall apply where the words "or approved equivalent" are used.
- A601.6.2 In these instances, the Contractor shall submit to the Employer for approval, a statement detailing the alternative material or equipment and shall include full technical descriptions, drawings and specifications and shall provide such further information as is required to demonstrate to the Employer that the alternatives are equivalent in every way to those specified.

- A601.6.3 Acceptance of the Contractor's offered alternatives shall be subject to the acceptance and approval of the Employer who shall not be bound to accept any such offer.
- A601.7 Delivery, Storage and Handling Requirements
- A601.7.1 No products, materials or equipment shall be delivered to site until the Contractor has established all traffic and environmental controls on site and has adequate facilities on site for unloading and storage of the products, material and equipment prior to their incorporation into the Works.
- A601.7.2 All products, materials and equipment delivered to site shall be handled and stored so as to prevent damage or deterioration prior to their incorporation into the permanent Works. All stockpiles and storage stacks shall be maintained by the Contractor in a safe state with sufficient working space provided to permit safe access by the Employer for inspection and checking of the delivered products, materials and equipment.
- A601.7.3 All proprietary products, materials and equipment used on the Works shall be handled, stored, used, fixed or applied strictly in accordance with the manufacturer's instructions and to the satisfaction of the Employer. The Contractor shall obtain the manufacturer's instructions in this regard at the time of ordering and shall submit to the Employer along with his submission of the proposed source.

A602 TESTS AND STANDARD OF ACCEPTANCE

- A602.1 General
- A602.1.1 All materials, even though stored in an approved manner, shall be subjected to an acceptance test prior to their immediate use.
- A602.1.2 Independent testing of cement for every consignment shall be done by the Contractor at site in the laboratory approved by the Employer before use. Any cement with lower quality than those shown in manufacturer's certificate shall be debarred from use. In case of imported cement, the same series of tests shall be carried out before acceptance.
- A602.2 Testing and Approval of Material
- A602.2.1 The Contractor shall furnish test certificates from the manufacturer/supplier of materials along with each batch of material(s) delivered to site.
- A602.2.2 The Contractor shall be responsible or testing of all materials, finished products used in the construction as per requirements of Conditions of Contract and the relevant Specifications. The testing of all the materials shall be carried out by the Employer or his representative for whom the Contractor shall make all the necessary arrangements and bear the entire cost.

A602.2.3 Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's expense at any recognised laboratory/testing establishments in India or abroad, as approved by the Employer. All necessary cost for witnessing the test by Employer's representative shall have to be borne by the Contractor.

A602.3 Rejection of Materials not conforming to the Specifications

A602.3.1 Any stack or batch of material(s) of which sample(s) do not conform to the prescribed tests and quality, shall be rejected by the Employer, or his representative, and such materials shall be removed from site by the Contractor at his own cost. Such rejected materials shall not be made acceptable by any modifications.

A602.4 Testing and Approval of Plant and Equipment

A602.4.1 All plant and equipment used for preparing, testing and production of materials for incorporation into the permanent Works shall be in accordance with manufacturer's specifications and shall be got approved by the Employer before use.

A700 PROJECT EXECUTION

A701 EXAMINATION AND PREPARATION

A701.1 Construction Work Method Statements

A701.1.1 In addition to the submission of the Detailed Construction Sequence and Methodology as defined in this Section, the Contractor shall submit separate individual Construction Work Method Statements (CWMS) detailing the sequence and method of working he intends to adopt for various items of works. The CWMS shall be consistent with the overall Detailed Construction Sequence and Methodology and shall comply with any additional construction sequence or phasing requirements nominated on the Drawings and/or elsewhere in this Specification. The purpose of the CWMS is to aid the planning and integration of activities and correct technical execution of the Works within the requirements of the Contract. In this regard, it shall be written such that it can be understood completely by the labour and supervisory personnel responsible for the Works.

A701.1.2 The CWMS shall provide detailed information regarding materials, equipment and plant to be utilised, labour requirements, time frame and schedule of the Works including SubContractors, prerequisite conditions, details and order of activities for each operation, safety measures, environmental controls and any other relevant technical aspects including those detailed elsewhere in the Specification or Drawings.

A701.1.3 The CWMS shall be consistent with the requirements of the approved Project Quality Plan and shall include a description of testing and inspection records, reporting channels (including names of responsible supervisory personnel) and frequency and actions where records indicate non-conformance with the Specification. The relevant agreed ITPs for the subject Works shall be appended to the CWMS for easy reference.

A701.1.4 Proposed repair methods for the rectification of any anticipated minor defects or damage shall also be appended to the CWMS.

A701.1.5 Where any construction activity includes an interface with either the existing operations, or with an associated contract, the CWMS shall also include the procedures to be followed by his staff and equipment for the management of such interfaces.

A701.1.6 Unless specifically noted otherwise in the relevant sections of this Specification, the Contractor shall submit the proposed CWMS to the Employer for approval at least 21 days prior to the intended date for first commencement of the construction Works to which the CWMS relates. The Employer will take maximum 14 days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

A701.1.7 The resolution of such comments on the CWMS submission will be to the satisfaction of the Employer and the Employers subsequent approval of the CWMS shall constitute a Hold Point on the commencement of the Works to which the CWMS relates.

- A701.1.8 Examination and/or approval by the Employer of the CWMS submitted by the Contractor shall not relieve the Contractor of his responsibilities or liabilities under the Contract. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor will remain with the Contractor, irrespective of any approval given by the Employer.
- A701.1.9 The Contractor shall be responsible for issuing copies of the approved CWMS to the relevant Works personnel and supervisory staff to ensure that they are fully familiar with the CWMS.
- A701.1.10 Notwithstanding any approval of the CWMS, the Employer shall reserve the right to require further amendment or modification of the CWMS in the event that additional issues are observed on site following commencement of the construction Works to which the CWMS relates. Similarly, the Contractor is free to propose further amendment or modification to the CMWS subject to the approval of the Employer.
- A701.2 Survey and Layout Data
- A701.2.1 Levels shall be set out to Port's Chart Datum (CD), which is 0.582 m below AMSL. Coordinates are based on the Indian Geodetic Datum survey grid system as adopted from the Survey of India.
- A701.2.2 The Reference Bench Mark for the area shall be obtained by the Contractor from the Employer. The Contractor shall establish working Bench Marks tied with the Reference Bench Mark in the area soon after taking possession of the site.
- A701.2.3 Throughout the duration of the Works, the Contractor shall be responsible for the establishment, maintenance and protection of suitable permanent and temporary benchmarks and control points for the setting out of the Works and for the correctness of all such setting out.
- A701.2.4 The Contractor shall provide sufficient permanent survey marks to properly set out the Works and shall take all necessary precautions to prevent these marks from being disturbed. The working Bench Marks/levels shall be as approved by the Employer. Checks must be made on these Bench Marks at least once every month and adjustments, if any, agreed with the Employer and recorded. An up-to-date record of all Bench Marks including approved adjustments, if any, shall be maintained by the Contractor and also a copy supplied to the Employer for his record.
- A701.3 Structures | Condition Survey
- A701.3.1 Prior to commencement of any construction Works in the vicinity of any structure owned or operated by the Employer/Government property or privately owned property, the Contractor shall undertake a Condition Survey of the in-situ position and condition of all area likely to be impacted by the Contractor's Works. The Condition Survey shall be carried out by suitably qualified persons approved by the Employer and it shall be capable of audit by third parties.
- A701.3.2 The Condition Surveys shall include all parts of the structure and surrounds likely to be impacted by the Contractor's operations and shall be subject to agreement with the Employer.

A702 DAMAGE TO EXISTING STRUCTURES

- A702.1 If, in the sole opinion of the Employer, the Contractor has caused damage to any part of an existing structure by unloading or loading or any other operations, the Contractor shall be responsible for carrying out repairs to the structure to the satisfaction of the Employer/relevant authority.
- A702.2 All costs and expenses associated with the repairs to such damage or the replacement of damaged parts shall be at the cost of Contractor.

A703 EXISTING UTILITIES AND SERVICES

- A703.1 All information regarding the existing or future utilities and services shown on the Drawings has been obtained and/or reproduced from various sources and is for indication only. The Contractor shall be responsible for making his own assessment of the exact details, lines, levels, nature, type, size, location and all other matters of relevance to the existing utilities and services at the site prior to commencement of any site Works.
- A703.2 Any unidentified services uncovered by the Contractor shall be immediately brought to the attention of the Employer.
- A703.3 The information on affected services and utilities may not be exhaustive and the final position of these services within the Works shall have to be drawn up based on the information furnished by different authorities linked with the utilities as directed by the Employer. The Contractor's programme must take into account the period of notice and duration of diversion work concerning each authority as given on the Drawings and the Contractor must also allow for any effect of these services and alterations upon the Works and for arranging regular meetings with the various authorities on commencement of the Contract and throughout the period of the Works in order to maintain the required co-ordination. During the period of the Works, the Contractor shall have no objection if the public utility bodies / authorities vary their decisions in the execution of their proposals in terms of programme and construction, provided that, in the opinion of the Employer, the Contractor has received reasonable notice thereof before the relevant alterations are put into operation.
- A703.4 The Contractor shall take every precaution to avoid damage to existing utilities and services at the site. No clearance or alterations of utilities or services shall be carried out unless specifically ordered by the Employer.
- A703.5 Any services affected by the Works must be temporarily supported by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the Works. The work of temporarily supporting and protecting the public utility services during execution of the Works shall be deemed to be part of the Contract and no extra payment shall be made for the same.
- A703.6 The Contractor may be required to carry out the removal or shifting of certain service/utilities on specific orders from the Employer. Such work shall be taken up by the Contractor only after obtaining clearance from the Employer and ensuring adequate safety measures.

A704 EXECUTION

A704.1 General

A704.1.1 In every case, the Works shall be carried out to the satisfaction of the Employer and conform to the location, lines, dimensions, grades and cross-sections shown on the drawings or as indicated by the Employer. The quality of materials, processing of materials as may be needed at the site, salient features of the construction work and quality of finished work shall comply with the requirements set forth in succeeding sections of this Specification.

A704.2 Radio Communications

A704.2.1 Any radio frequencies proposed for use by the Contractor for site communications shall be subject to the approval of the Employer or relevant Authority. The Contractor shall be responsible for arranging all permits and licences required for the operation of radio equipment throughout the Works.

A704.3 Construction Plant and Equipment

A704.3.1 In addition to the general conditions indicated in the Contract Documents, the following conditions regarding use of equipment in executing the works shall be satisfied:

- (a) The Contractor shall be required to give a trial run of the equipment for establishing their capability to achieve the laid down Specifications and tolerances to the satisfaction of the Employer before commencement of the Works;
- (b) All equipment provided shall be of proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Employer;
- (c) All the plant/equipment to be deployed on the Works shall be approved by the Employer for ensuring their fitness and efficiency before commencement of work;
- (d) Any material or equipment not meeting the approval of the Employer shall be removed from the site forthwith;
- (e) No equipment shall be removed from site without permission of the Employer; and the Contractor shall also make available the equipment for site quality control work as directed by the Employer;
- (f) All equipment shall comply with the environmental requirements set out in this Document; and.
- (g) No batching plant and stone crushing plant are allowed inside the Project Site.

A705 MARINE / FLOATING EQUIPMENT

- A705.1 All crafts used for the Contract shall be registered in accordance with applicable laws/regulations and the masters/operators may themselves require local licences and certificates as required by the Employer and any other applicable regulations. All vessels, working craft and other floating equipment shall display appropriate international and local signals to indicate the nature of their work. All work over water must comply with all relevant regulations of the Kerala State Inland Navigation Corporation/CoPT.
- A705.2 Floating equipment shall be maintained in a satisfactory and seaworthy condition and shall have adequate attendance by competent seamen at all times, shall be fully provided with sound and satisfactory ropes, lines and moorings and shall be fully equipped with lights. At all times, the Contractor shall be wholly responsible for the protection and safety of all floating craft engaged by him.
- A705.3 Where work is carried out from dumb lighters, pontoon or other non-self-propelled floating equipment, a suitably powered craft shall be in attendance at all times.
- A705.4 All marine craft, pontoons or platforms shall be adequately braced, secured and anchored and of such size and construction as to ensure a satisfactory performance of the Work. The marine craft shall also be fitted out to allow the types of investigation, sampling and in-situ testing required to be carried out to the satisfaction of the Employer. The Contractor shall provide the Employer with adequate assistance for gaining access to the marine crafts, pontoons or platforms.
- A705.5 Areas of temporary anchorage of Contractor's marine craft shall be agreed with the Employer, shall be outside any permanent or temporary navigation channel and shall be clearly marked with marker buoys or other system to the satisfaction of the Harbour Master of Cochin Port Trust.
- A705.6 All lifesaving, fire equipment, medical facilities shall be maintained as required by relevant code or comparable requirements.
- A705.7 The originals of all statutory certification including but not limited to the following documentation shall be kept on-board all vessels deployed on the Works:
- (a) Certificate of Registry;
 - (b) Load Line Certificate;
 - (c) Tonnage Certificate;
 - (d) Certificate of Class (Hull and Machinery);
 - (e) Cargo Ship Safety Certificate;
 - (f) Life Saving Apparatus Certificate;
 - (g) De-rating Certificate;

- (h) Quarantine Certificates for Ballast Water and Hull Cleanliness prior to entering Indian Waters;
- (i) Radio Certificate; and
- (j) Stability Booklet for loading conditions, as may be foreseen for the Works

A705.8 Vessels shall be operated at all times during the Works within the limits of its current Vessel Marine Documentation and Certification.

A706 CRANES AND LIFTING EQUIPMENT

A706.1 All cranes, lifting equipment and winches shall comply with Indian and Local Government requirements and third party surveyor requirements, for example Lloyds, B.V., DNV, ABS, and Indian Safety Authority or similar approved.

A706.2 Test certificates, maintenance records and the like for all cranes, wires, slings and winches shall be available for inspection by the Employer and for third party audit. Slings for which test certificates are not available shall not be used and shall be removed from site prior to the commencement of the Works.

A707 REPAIR METHODS

A707.1 The Contractor shall submit to the Employer for approval, details of all proposed repair methods to be employed as may be necessary to rectify any minor defects or incidental damage in elements of the permanent Works.

A707.2 Details shall include but not be limited to information on the type and manufacturer of any proprietary products to be used and any specific directions from the manufacturer regarding their use, detailed work methods for affecting the repairs and any other relevant technical information as may be required by the Employer.

A707.3 The Contractor shall generally submit these details pre-emptively as part of his CWMS for the relevant construction activity. Where additional or unforeseen repairs are required, the Contractor shall make additional submission as directed by the Employer.

A708 CLEANING AND WASTE MANAGEMENT

A708.1 Site Maintenance

The Works includes the housekeeping of the Site including but not limited to:

- (a) Daily cleaning of the Site including all amenities and facilities supplied by the Contractor to the Employer;
- (b) Collection and disposal of all domestic, toxic and hazardous waste, oils, empty drums and other containers, waste timber, asbestos impregnated products all in accordance with all applicable Laws and regulations governing the disposal of these items or materials;

- (c) Retrieval of any waste materials deposited on the sea bed by the Contractor;
- (d) Collection and storage of all surplus construction material;
- (e) Special clean-ups required throughout the monsoon season and tie down Works required for cyclone alerts including any damage preventative measures to both temporary facilities and amenities and to partly or wholly constructed installations and enclosures;
- (f) Final clean-up and re-instatement of the Site;
- (g) Compliance with all environmental protection requirements.

A708.2 Construction Waste Management and Disposal

A708.2.1 The Contractor is required to implement procedures for waste minimization to reduce, reuse, recycle and recover as much waste material or reuse as is practical. Waste minimization and segregation shall be exercised during mobilisation, installation, execution and demobilization phases of the Works.

A708.2.2 The Contractor shall endeavour to minimise waste materials such as equipment consumables, packaging and the like. All scrap generated during construction shall be segregated into components such as glass, paper products, aluminium, steel, rubber, insulation materials, plastics, steel, wood and the like.

A708.2.3 All demolished and excavated material, excess building materials and waste, other than material designated to be stockpiled on the site, shall be removed from the Site and disposed off, in a legal manner. No waste shall be disposed in the Coastal Regulation Zone (CRZ) area. All permits and approvals necessary for the removal and disposal of demolition materials shall be obtained in advance. The municipal wastes generated by labour during construction, shall be handled, transported and disposed as per the relevant municipal handling rules.

A708.2.4 All unused material shall be removed from site in a progressive manner either by use of a weekly emptied dump hopper or similar removal arrangement. The sellable wastes shall be sold only to the authorized vendors. The Site and surrounds shall be kept tidy at all times.

A708.2.5 Plastics and rubber shall not be disposed off by burning and is to be handled and disposed as per the draft plastic rules. Asbestos use shall be minimized and shall be disposed off, in accordance with all relevant regulations. Materials infested by vermin, pests or rot shall be destroyed in a way that will minimise the risk of infecting other materials. Hazardous wastes shall be handled, stored, managed and disposed off, in compliance with the relevant regulations.

A708.2.6 The Contractor shall take all precautions to ensure that with the exception of materials that will form part of the Works, no materials of any kind being used or transported to or from the Site fall on adjoining property or public thoroughfares or into the water. Any material or item that does so fall shall be removed as early as practical, to the satisfaction of the Employer.

A708.2.7 Construction and demolition (C&D) wastes from this Contract shall remain the property of the Contractor and shall be removed by the Contractor from the Site or adjoining area as applicable to the satisfaction of the Employer. All such work shall be carried out at the Contractor's own expense for which payment shall be deemed to have been included in the Contract Sum.

A708.2.8 If there is any change in the existing rules and the new rules become effective for the construction, transportation, treatment and disposal for municipal, hazardous, C&D, electrical and electronic and plastic wastes, the new rules have to be followed. All such work shall be carried out at the Contractor's own expense for which payment shall be deemed to have been included in the Contract Price.

A709 PROTECTING INSTALLED CONSTRUCTION

A709.1 The Contractor shall follow procedures and assignments as contained in the Project Site Management Plan and will minimize impact to the ongoing operations wherever possible, or as directed by the Employer.

A710 COMPLETION PROCEDURES

A710.1 General

A710.1.1 Requirements for Tests on Completion, Employer's Taking Over of the Works and Defects Liability shall be as per the requirements of the Conditions of Contract and subject to the additional requirements outlined in this Specification. The additional requirements specified in the following sections shall not be interpreted as limiting the Contractor's responsibilities under Contract in this regard in any way.

A710.2 Preliminary Inspection of the Works at Completion

A710.2.1 In addition to the requirements of the Contract regarding Tests on Completion, the Contractor shall undertake joint general inspection of the completed Section with the Employer and Indian Navy, at least 14 days prior to the Contractor's intended submission of application for a Taking-over Certificate for the Section.

A710.2.2 The Contractor shall record any and all defects or omissions identified during the joint inspection including any, that in the sole opinion of the Employer and/or Indian Navy, are required to be rectified prior to the issue of a Taking-Over Certificate and those that may be rectified after issue of the Taking-Over Certificate under Defects Liability.

A710.2.3 Following the joint inspection, the Contractor shall submit the agreed Draft List of Defects and Minor Omissions including the agreed disposition with respect to the timing and method of rectification of each to the Employer for approval. The Contractor shall also include on the List any outstanding documentation or administrative requirements under the Contract. The Contractor shall advise the date for rectification of each individual item on the Draft List of Defects and Minor Omissions.

A710.2.4 The acceptance of this Draft List of Defects and Minor Omissions by the Employer shall constitute a Hold Point on the submission of application for a Taking-Over Certificate for the Section by the Contractor.

- A710.3 Inspection of the Works at Completion
- A710.3.1 Within 7 days following receipt of the Contractor's application for a Taking-Over Certificate for the Section (subject to the requirements above), the Contractor shall undertake a further joint general inspection of the Section with the Employer
- A710.3.2 This final inspection shall be to confirm that all items previously identified on the Draft List of Defects and Minor Omissions as being required to be rectified prior to issue of the Taking-Over Certificate, have been rectified and to re-confirm the status of the items permitted to be rectified after issue of the Taking-Over Certification for the Works under Defects Liability.
- A710.3.3 Following the joint inspection, the Contractor shall submit the agreed Final List of Defects and Minor Omissions including the agreed disposition with respect to the timing and method of rectification of each to the Employer for approval.
- A710.3.4 The acceptance of this Final List of Defects and Minor Omissions by the Employer as well as completion of all Tests on Completion and submission of all other required documentation and submittals per the requirements of the Contract shall constitute a Hold Point on the issuing of the Taking-over Certificate for the Section.

A711 SUBMITTALS AT COMPLETION

- A711.1 Operation and Maintenance Data
- A711.1.1 The Contractor shall provide a full set of all operations and maintenance manuals as may be required under the Contract in hard copy (03 No. copies) and electronic PDF format to the Employer prior to submittal of the Contractor's application for a Taking-Over Certificate for the completed Section.
- A711.1.2 These manuals shall provide sufficient detail for the Employer to operate, maintain, dismantle, reassemble, adjust and repair the Plant/Structure. The wording of all such manuals shall be agreed with the Employer in advance.
- A711.1.3 A Section shall not be considered to be completed for the purposes of Taking Over as defined in the Conditions of Contract until the Employer has received in the form required by the Contract, final operation and maintenance manuals in such detail, and any other manuals specified in the Specifications and the Drawings for these purposes.
- A711.2 As-Built Drawings
- A711.2.1 The Contractor shall prepare, and keep up-to-date, a complete set of "As-Built" records of the execution of the Works, showing the exact as-built locations, sizes and details of the Work as executed. These records shall be kept on the Site and shall not be used by the Contractor for any purpose other than for the purposes of the preparation of the As-Built Drawings in accordance with the requirements of the Contract.
- A711.2.2 The Contractor shall prepare a full set of As-Built drawings for the whole of the Works based on the Contract Drawings with amendments made to reflect any major changes in set out, design or construction method.

- A711.2.3 All dimensions, levels and set-out coordinates shall be updated based on the in-survey, progress and As-built surveys undertaken throughout the Works. Additional information on the As-Built pile founding depths and set-out shall be added to the drawings based on the Contract piling records.
- A711.2.4 The Contractor shall submit the draft As-Built drawings in hard copy (03 No. A3) and electronic CAD and PDF format to the Employer for approval prior to the submittal of the Contractor's application for a Taking-Over Certificate for the completed Works.
- A711.2.5 The Contractor shall incorporate all comments and amendments required by the Employer and once agreed, shall submit the final As-Built Drawings in hard copy (03 No. A3 and 03 No. A1) and electronic CAD and PDF format to the Employer.
- A711.2.6 The Works shall not be considered to be completed for the purposes of Taking Over as defined in the Conditions of Contract until the Employer has received these documents in the form required by the Contract.

A712 WARRANTIES

- A712.1 The Contractor shall provide a full set of all warranties for products of workmanship as may be required under the Contract in hard copy (02 No. copies) and electronic original format and PDF format to the Employer prior to submittal of the Contractor's application for a Taking-over Certificate for the completed Section.
- A712.2 The wording of all such warranties shall be agreed with the Employer and the Employer in advance.

A713 PROJECT RECORD DOCUMENTS

- A713.1 The Contractor shall provide a full set of the Project Quality Records in hard copy (02 No. copies) and electronic original format and PDF format to the Employer within 28 days of issue of the Taking-Over Certificate for the completed Section.
- A713.2 The Contractor shall maintain separate volume covering Quality Documentation for any outstanding minor Works carried out under Defects Liability Period. This separate volume shall be submitted to the Employer at least 14 days prior to the expiration of the Contract Defects Liability Period.

VOLUME-II
SECTION 6B
SPECIFICATIONS FOR CIVIL AND MARINE WORKS

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B100 GENERAL

B101 APPLICATION

- B101.1 These Technical Specifications shall apply to all works as are required to be executed under the Contract or otherwise directed by the Employer (as defined in the Conditions of Contract).
- B101.2 The Specifications must be read in conjunction with the Scope of Work, Design Criteria, Particular Conditions, General Conditions of Contract, Drawings and other documents forming the Contract documents.

B200 SITE CLEARING AND DEMOLITION

B201 GENERAL

B201.1 The Section of the Specifications covers the construction requirements for site clearance and demolition works required for the construction of Jetty, reclamation and onshore facilities as shown on the Drawings or as directed by the Employer.

B201.2 Construction Work Method Statement

B201.2.1 The Contractor shall submit a Construction Work Method Statement (CWMS) for all sites clearing and demolition works in accordance with the general requirements specified in General Specifications and incorporating all additional detailed technical requirements as specified in this section.

B201.2.2 The Contractor's CWMS shall include details of all proposed safety and environmental controls to be employed in carrying out the works.

B201.2.3 The Contractor's CWMS shall include details of procedures and certification/permits to be employed to ensure that all existing services are identified, protected, terminated, isolated or otherwise made safe prior to the commencement of the work.

B201.2.4 The Contractor shall submit his CWMS for approval at least 14 days prior to the intended date for first commencement of the site clearance and demolition works. The Employer will take maximum 7 days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

B201.2.5 The resolution of such comments on the CWMS submission to the satisfaction of the Employer and the Employer's subsequent approval of the CWMS shall constitute a HOLD POINT on the commencement of site clearance and demolition works.

B201.2.6 Only such methods, tools and equipment as are nominated in the Contractors approved CWMS and which will not affect the property to be preserved shall be adopted for the Work.

B202 DISCONNECTION AND ISOLATION OF SERVICES

B202.1 All existing services affected by the demolition works shall be disconnected, isolated and/or relocated or otherwise made safe prior to commencement of demolition work.

B203 CLEARING AND GRUBBING

B203.1 Scope

B203.1.1 This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish, buried defunct utilities, concrete blocks etc., which in the opinion of the Employer are unsuitable for incorporation in the Permanent Works.

B203.2 The Contractor shall carry out such works in areas of the site containing existing structures; paved / unpaved backup area, drains and such other areas as may be specified on the drawings or by the Employer to the extent necessary for the construction of the permanent works.

B203.3 It shall include necessary excavation, backfilling of pits and trenches resulting from uprooting of trees, stumps, existing foundations and utility lines to required compaction to make the surface at these points conform to the surrounding area, handling, salvaging, and disposal of cleared materials.

B204 PRESERVATION OF PROPERTY/AMENITIES

B204.1 Trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all other existing facilities within or adjacent to the project land which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own expense, suitable safeguards approved by the Employer for this purpose.

B204.2 During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution etc., and where required, undertake additional works to that effect in accordance with the general requirements of these specifications and to the satisfaction of the Employer. Before start of operations, the Contractor shall submit to the Employer for approval, his work plan including the procedure to be followed for disposal of waste materials etc., and the schedules for carrying out temporary and permanent erosion control works in accordance with the requirements of the Contract.

B205 METHODS, TOOLS AND EQUIPMENT

B205.1 Only such methods, tools and equipment as are approved by the Employer and which will not affect the property to be preserved shall be adopted for the Work.

B206 DISPOSAL OF MATERIALS

B206.1 All materials arising from clearing and grubbing operations shall be removed from the Site and disposed of by the Contractor as per approved CWMS or as directed by the Employer. Burning of materials on-site shall not be permitted.

B206.2 Disposal of materials outside the Site by the Contractor shall be subject to all applicable laws and regulations including the requirements of all relevant Authorities. The Contractor shall be responsible for obtaining all applicable Permits, Permissions and Statutory Approvals in this regard. The Contractor shall be responsible for meeting all costs associated with disposing of materials, including any tipping and haulage fees which may be levied.

B300 EARTHWORKS

B301 GENERAL

B301.1 The section of the Specification covers the materials and construction requirements for the excavation and disposal or re-use of materials, site formation and pavement subgrade preparation, and all other earthworks as required for the construction of pavement, services and structures for Jetty, access infrastructure and related construction according to lines, grades and cross-sections shown on the Drawings or as directed by the Employer.

B302 CONSTRUCTION WORK METHOD STATEMENT

B302.1 The Contractor shall submit a Construction Work Method Statement (CWMS) for all earthworks activities in accordance with the general requirements as specified in the Specifications and incorporating all additional detailed technical requirements as specified in this section.

B302.2 In broad terms, CWMS for excavation works shall include but not be limited to the following items subject to the additional technical requirements for pavement works as specified herein:

B302.3 Overall excavation sequence and proposals for the management and transport of all materials in the earthworks including the sorting of excavated material, stockpiling and management of excavated materials suitable for re-use, stockpiling and disposal of unsuitable materials and the management of other surplus excavated material;

B303 METHODS, TOOLS AND EQUIPMENT

B303.1 Only such methods, tools and equipment as nominated in the Contractors approved CWMS or as otherwise approved by the Employer shall be adopted/used in the work.

B304 SETTING OUT

B304.1 The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as in the opinion of the Employer, they are required for the work.

B305 DRAINAGE AND DEWATERING

B305.1 The Contractor shall plan and carry out all stages of the Works in a manner that avoids erosion, ponding, softening, saturation, contamination and sedimentation of the Site and surrounding areas.

B305.2 The Contractor shall provide all necessary control measures, which may include:

- (a) Construction of temporary drains;
- (b) Pumping and/or dewatering of excavations;
- (c) Diversion of concentrated flows to points where they can pass through the Works without damage;

- (d) Construction and maintenance of silt traps;
 - (e) Staging of earthworks; and
 - (f) Progressive restoration of disturbed areas throughout the project.
- B305.3 Any area which becomes damaged as a result of the effects of water shall be repaired by the Contractor.
- B305.4 The Contractor shall arrange for the rapid dispersal of water collected/accumulated on the earthwork or completed formation during construction or on the existing roadway or which enters the earthwork or any other item of work from any source, and where practicable, the water shall be discharged into the permanent outfall of the drainage system or as directed by Employer. The Contractor shall provide, where necessary, temporary water courses, ditches, drains, pumping or other means for maintaining the earthwork free from water. Such provisions shall include carrying out the work of forming the cut sections and embankments in such manner that their surfaces have at all times a sufficient minimum cross fall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.
- B305.5 Care shall be taken to discharge the drained water so as not to cause damage to the works. If any such damage is caused due to any negligence on the part of the Contractor, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.
- B305.6 Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as it is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipment's etc., inside the enclosed area.
- B305.7 At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.
- B305.8 The works involved in keeping the earthwork or any other item of works free of water shall be deemed as incidental to the respective item of work and as such no separate payment shall be made for the same.
- B306 STABILITY AND DEGRADATION**
- B306.1 The Contractor shall carry out all excavation, filling and associated earthworks in a manner, which avoids creating unstable slopes or degradation of materials forming part of the Permanent Works.
- B306.2 Any area which becomes damaged as a result of instability or degradation shall be removed to the extent affected and replaced by the Contractor. The costs of any measures to prevent instability and degradation and remedial works shall be borne by the Contractor.

B307 PROTECTION OF FINISHED EARTHWORKS

- B307.1 The Contractor shall protect finished earthworks of reclaimed areas from construction or other vehicular traffic, weather and erosion and keep them free of rubbish and debris and repair and re-establish grades in settled, eroded and rutted areas to the specified tolerances.
- B307.2 Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, the Contractor shall scarify the surface, reshape and compact to the required density in accordance with these specifications prior to further construction.
- B307.3 Construction traffic and other vehicular traffic shall not traverse or bear on the cut formation, prepared surface of the filling or finished subgrade unless permitted by the Employer. Any damage arising out of such use shall be made good by the Contractor at his own expense.

B308 SAFETY OF EXCAVATIONS

- B308.1 All excavations shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents and all other measures as may be nominated in his approved Health and Safety Management Plan. The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures. For safety precautions, guidance may be taken from IS: 3764.

B309 EARTHWORKS MATERIALS

B309.1 General

- B309.1.1 The Contractor shall be responsible for his assumptions made in relation to the nature and types of materials as encountered in excavations or imported, and the bulking and compaction characteristics of all such materials which are to be incorporated into the works.
- B309.1.2 The Contractor shall make adequate allowance for the effects of handling and placement of materials on material properties and shall supply materials and use handling and placement techniques which ensure that the specified material properties are achieved. Disposal of excess excavated materials outside the Site by the Contractor shall be subject to all applicable laws and regulations including the requirements of all relevant Authorities. The Contractor shall be responsible for obtaining all applicable Permits, Permissions and Statutory Approvals in this regard. The Contractor shall be responsible for meeting all costs associated with disposing of materials, including any tipping and haulage fees which may be levied.

B310 SETTING OUT

B310.1 After the site has been cleared in accordance with the requirements of above, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Employer. Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as in the opinion of the Employer, they are required for the work.

B311 EXCAVATION

B311.1 All excavations shall be carried out in conformity with the directions laid here-in-under and in a manner approved by the Employer.

B311.2 While planning or executing excavations, the Contractor shall take all adequate precautions against soil erosion, water pollution etc. in accordance with the general requirements of these specifications and shall take appropriate drainage measures to keep the site free of water.

B311.3 The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Employer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/width excavated beyond the specified levels/dimensions on the drawings shall be backfilled with Select Fill placed and compacted in accordance with the requirements of the Specification at the cost of the Contractor.

B311.4 All debris and loose material on the sides of cuttings shall be removed. No backfilling shall be allowed to obtain required side slopes excepting that when boulders/concrete or soft materials are encountered in cut slopes, these shall be removed and the resulting cavities backfilled with Select Fill placed and compacted in accordance with the requirements of the Specification.

B311.5 After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place.

B400 MATERIALS FOR CONSTRUCTION – GENERAL REQUIREMENTS

B401 GENERAL

B401.1 Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these specifications.

B401.2 If any material, not covered in these specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Employer.

B402 SOURCES OF MATERIAL

B402.1 The Contractor shall notify the Employer of his proposed sources of materials prior to delivery. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from other sources at his own expense.

B403 STORAGE OF MATERIALS

B403.1 General

B403.1.1 All materials shall be stored at proper places so as to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The storage space must also permit easy inspection, removal and re-storage of the materials. All such materials even though stored in approved godowns/places, must be subjected to acceptance test prior to their immediate use.

B403.2 Aggregates

B403.2.1 Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard, levelled and well drained. If necessary, the ground shall be covered with 50 mm plank.

B403.2.2 Aggregates placed directly on the ground shall not be removed from the stockpile within 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

B403.3 Cement

B403.3.1 Cement shall be transported, handled and stored on the site in such a manner so as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and water-tight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.

B403.3.2 Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the Contractor without charge to the Employer.

B403.3.3 The Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Employer at all times.

B403.3.4 The Contractor shall make a monthly return to the Employer on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

B403.4 **TMT Reinforcement**

B403.4.1 The TMT reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms, skids, or other supports with well-drained surface, and shall be protected from mechanical injury and from deterioration by exposure.

B403.5 **Water**

B403.5.1 Water shall be stored in containers/tanks covered at top and cleaned at regular intervals in order to prevent intrusion by foreign matter or growth of organic matter. Water from shallow, muddy or marshy surface shall not be permitted. The intake pipe shall be enclosed to exclude silt, mud, grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

B404 TESTS AND STANDARD OF ACCEPTANCE

B404.1 **General**

B404.1.1 All materials, even though stored in an approved manner shall be subjected to an acceptance test prior to their immediate use.

B404.1.2 Independent testing of cement for every consignment shall be done by the Contractor at site in the laboratory approved by the Employer before use. Any cement with lower quality than those shown in manufacturer's certificate shall be debarred from use.

B405 TESTING AND APPROVAL OF MATERIAL

B405.1 The Contractor shall furnish test certificates from the manufacturer/supplier of materials along with each batch of material(s) delivered to site.

B405.2 The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction as per requirements of conditions of contract and the relevant specifications. The testing of all the materials shall be carried out by the Employer or his representative for which the Contractor shall make all the necessary arrangements and bear the entire cost.

B405.3 Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's expense at any government recognized laboratory/testing establishments in India or abroad as approved by the Employer. All necessary cost for witnessing the test by Employer's representative shall have to be borne by the Contractor.

B406 SAMPLING OF MATERIALS

- B406.1 Samples provided to the Employer or his representative for their retention is to be in labelled boxes suitable for storage.
- B406.2 Samples required for approval and testing must be supplied well in advance at least 48 hours or minimum period required for carrying out relevant tests to allow for testing and approval. Delay to works arising from the late submission of samples will not be acceptable as a reason for delay in the completion of the works.
- B406.3 If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall have to be borne by the Contractor.

B407 REJECTION OF MATERIALS NOT CONFORMING TO THE SPECIFICATIONS

- B407.1 Any stack or batch of material(s) of which sample(s) does not conform to the prescribed tests and quality shall be rejected by the Employer or his representative and such materials shall be removed from site by the Contractor at his own cost. Such rejected materials shall not be made acceptable by any modifications.

B408 TESTING AND APPROVAL OF PLANT AND EQUIPMENT

- B408.1 All plants and equipment used for preparing, testing and production of materials for incorporation into the permanent works shall be in accordance with manufacturer's specifications and shall be got approved by the Employer before use.

B500 CAST-IN-SITU CONCRETE PILES

B501 GENERAL

B501.1 Cast-in-situ concrete piles shall be constructed by driving or sinking non-structural tubular steel casings into the ground upto refusal, excavating all material from inside the casing, placing reinforcement and then filling the casings with concrete. The steel casings shall remain permanently in place and shall form part of the permanent works.

B502 CONSTRUCTION WORK METHOD STATEMENT

B502.1 The Contractor shall submit a Construction Work Method Statement (CWMS) for all piling works in accordance with the general requirements as specified in the specifications and incorporating all additional detailed technical requirements as specified in this section.

B502.2 In broad terms, the Contractor's CWMS for piling works shall include but not be limited to the following items subject to the additional technical requirements for piling works as specified herein for approval of Employer:

- (a) Description of overall piling works construction sequence and programme trial piles and routine testing of working piles (Static as well as Dynamic);
- (b) Details of proposed materials for use in the piling works, including description, source and material test results or certificates demonstrating conformance of the materials to the requirements of these specifications;
- (c) Details of construction methods for the piling works including but not limited to details of:
 - (i) Temporary works or bracing;
 - (ii) Survey set out and control;
 - (iii) Trial Piles to be constructed and testing methods;
 - (iv) Piling, excavation and other plant, equipment and labour to be used;
 - (v) Any safety, environmental or other controls to be employed;
- (d) Contingency plans or procedures to be employed in the event of unforeseen interruption of piling works due to adverse weather, obstructions, plant breakdown, or other malfunction;
- (e) Details of inspection, test methods and analysis or calculations to be undertaken to ensure conformance of the constructed piles with the requirements of these specifications.
- (f) Details of methods for rectification in the event of non-conformance of either materials or construction requirements of these specifications;
- (g) Details of piling records to be kept including pro-forma piling records;

B502.3 Depending on the Contractors proposed sequence and programme of works, and subject to the agreement of the Employer, the Contractor may choose to either submit a single CWMS covering all piling works under the Contract, or a number of CWMSs covering individual sections of the piling works.

B502.4 Irrespective, the Contractor shall submit his CWMS for approval at least 28 days prior to the intended date for first commencement of the piling works to which the CWMS refers. The Employer will take maximum 10 working days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

B502.5 The resolution of such comments on the CWMS submission to the satisfaction of the Employer and the Employer's subsequent approval of the CWMS shall constitute a HOLD POINT on the commencement of the piling works to which the CWMS refers.

B503 NOTIFICATION OF PILING WORKS AND WEEKLY REPORTING

B503.1 The Contractor shall give at least 48 hours' advance notice to the Employer prior to commencing the first pile to enable the Employer or his representative to be present.

B503.2 The Contractor shall submit to the Employer each week his working programme for the piling works scheduled for the following week including a breakdown of activities planned for each day such that the Employer can coordinate his inspection of the works.

B504 PROTECTION OF EXISTING UTILITIES, SERVICES AND STRUCTURES

B504.1 The position of existing utilities shall be determined and underground utilities adjacent to the piles shall be exposed or otherwise accurately located before piling works start.

B504.2 All necessary measures shall be taken to minimise the settlement of the ground and adjacent structures and utilities and to prevent the formation of cavities in the ground resulting from piling works.

B504.3 The vibrations due to piling works at structures, utilities and previously installed piles measured in terms of peak particle velocity shall not exceed 25 mm/s.

B504.4 The vibrations due to piling works at structures, utilities and previously installed piles measured in terms of vibration amplitude shall not exceed 0.2 mm.

B504.5 The Contractor shall be responsible for and shall bear the cost of any claims for damage to adjacent structures and facilities arising from the execution of the piling works.

B505 MATERIALS

B505.1 General

B505.1.1 The basic materials shall conform to the specifications for materials given in the tender document. The specifications for steel reinforcement, structural concrete, and structural steel to be used in pile foundations shall be as given in the relevant sections of these specifications.

B505.2 Pile Casings

B505.2.1 The quality and thickness of steel for the permanent sacrificial casings shall be commensurate with the installation method and ground conditions including differential soil and hydrostatic pressure to the satisfaction of the Employer. Permanent casings shall have minimum thickness of 6mm or as specified on the Drawings.

B505.2.2 Permanent casings shall be free before and after installation from significant distortions and internal projections which might prevent the proper formation of the piles.

B505.2.3 Where permanent casings are to be made from a series of short sections they shall be joined and installed so as to have a constant internal diameter.

B505.2.4 Permanent casing joints shall be welded to form a continuous shaft.

B505.2.5 Details of the pile casings shall be proposed by the Contractor for the acceptance of the Employer as part of the CWMS for the piling works.

B506 SETTING OUT

B506.1 The Contractor shall check the casing position for each pile during and immediately after placing the casing and agree it with the Employer.

B506.2 Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile casing, the pile casing position shall be marked with suitable identifiable markers.

B507 REQUIREMENTS FOR PILE FOUNDING LEVELS

B507.1 All bored piles in the works shall be socketed into the hard strata for the minimum length or terminated upto the required level.

B507.2 Estimated pile founding levels shall be shown for all piles in the Good for Construction (GFC) Drawings based on the data obtained from geotechnical investigations.

B507.3 These estimated pile founding levels are indicative only and shall not be taken as in any way limiting the requirements of this section with respect to the requirements for proposed and final pile founding levels or the acceptance of piles by the Employer.

B507.4 SPT shall be conducted during the boring of pile at regular intervals as per the directions of the Employer and before founding the pile SPT shall be conducted at the proposed founding level. Founding level of each pile will be individually approved by the Employer satisfying himself from observations and all data including SPT tests at his disposal, of the soundness of the end bearing stratum. In case of rocky strata the pile shall be socketed a minimum of one diameter of the pile or as directed by the Employer. In other soils the penetration shall be as per design, with the approval of the Employer.

B507.5 During the drilling of piling works any anomalies like cavities at the drill locations which could not be observed during pre-drilling works should be informed to the Employer. The Employer will review the available data and confirm the required founding level for that pile or group of piles.

B508 EXCAVATION FOR PILES

B508.1 Excavation of the pile bore within the casing shall be carried out by mechanical methods using rotary type equipment such as reverse circulation drilling or other approved method by Employer. Blasting and compressed air shall not be used unless permitted by the Employer.

B508.2 Pumping of water during excavation shall not be permitted unless the casing has been driven to the specified depths so as to prevent massive flow of water into the excavation.

B508.3 Excavation shall not be carried out within a distance of five times the pile diameter to a pile which has been excavated but not yet cast with concrete, nor within a distance of five times the pile diameter to a pile which was cast less than 2 days earlier or for which the concrete cube strength at the time of excavation is less than 10 N/mm² or which contains concrete in the opinion of the Employer that may be damaged by such excavation.

B508.4 On completion of excavation, any loose, disturbed or remoulded soil shall be removed from the base of the excavation and the base cleaned. In under water excavation, cleaning shall continue until the water is clear and free of particles of soil. Measures shall be taken to prevent the accumulation of silt and other material at the base of the excavation.

B508.5 The Contractor shall flush out and extract from the pile excavation any fine-grained debris as required that may remain at the pile founding level. The Contractor's proposals for satisfying this requirement shall be included as part of his CWMS for the piling works for submission for the Employer's approval before piling work commences on site.

B509 INSTALLATION OF PERMANENT PILE CASINGS

B509.1 All marine piles shall be constructed within permanent MS sacrificial liner/casing as per the site conditions or as shown on GFC drawings. The pile casings shall be installed using suitable pile driving equipment to extend through all type of soil strata up to minimum 10 m below design dredged level or refusal, whichever is lower level, as defined in these specifications or as instructed by the Employer.

- B509.2 The pile casings shall be installed from firm ground or from temporary supports or from fixed platform. The arrangement shall provide sufficient rigidity to ensure accuracy of pile casing driving under all conditions of tide, stream flow or hammer drop. Pile casings shall be driven from a fixed frame of sufficient rigidity to ensure accuracy of driving within specified tolerances.
- B509.3 Pile casings shall not be driven eccentrically from the designed axis or bent into position and shall be effectively guided during driving. Attempts to correct any tendency for the pile to run off-line by the application of significant horizontal restraint will not be permitted. Shortly after the commencement of driving and at regular intervals throughout the driving operation, checks shall be made to ensure that the pile frame does not exert any undue lateral force on the pile due to restraint within the helmet.
- B509.4 For piles used in soils liable to flow, the driving of casing shall be achieved by continuous removal of muck from the bore thereby filling with required consistency and viscous polymeric slurry preventing the formation of cavities and settlements in the adjoining ground. Any joints in the casing shall be made as water-tight as possible to minimize inflow of water or leakage of slurry during concreting.
- B509.5 If the indications are that a pile casing will finish outside the specified tolerances, driving operations on that pile casing will cease. The pile casing shall be withdrawn, the hole filled and the pile casing re-driven at no extra cost.
- B509.6 To avoid the possibility of premature “set-up” pile casing driving shall be continuous in the later stages, without any deliberate stops. (Delays of an hour or more may lead to significant “set-up” in piles i.e. resistance to further driving increases after driving is stopped).
- B509.7 If any pile casing is damaged in any way during driving, it shall be repaired or replaced as directed by the Employer, at no extra cost. If during driving, the head of a pile is damaged to the extent that further driving is not possible, the head shall be cut off and driving continued. The cost of cutting off shall be borne by the Contractor and where, as a result of such cutting off the head, the pile is too short, the Contractor, shall, at his own cost, supply and splice on sufficient length of pile to restore the pile to its correct length.
- B509.8 Liner or pile bore which is improperly located or shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Employer at the cost of the Contractor.
- B509.9 The Contractor shall include all details of the pile casings and the proposed methods of installation as part of his CWMS for the works as specified earlier in this Section.
- B510 PILE BORE BOTTOM CLEANING**
- B510.1 Prior to placing concrete, polymeric slurry flushing at high pressure shall be done in the same way as the pre-bore flushing but using tremie pipes connected to polymer pump. At the end of flushing, contractor shall ensure that heavy contaminated polymer suspension has not settled at bottom of pile bore

B510.2 Immediately after the completion of boring, flushing of the borehole shall be done with the chisel in position for a period not less than one hour. After removing the chisel, the bore hole shall be further cleaned with a suitable bailer having adequate weight. The pile bore shall be cleaned using either by Reverse Mud Circulation (Air Lift Flushing) or Direct Mud Circulation (Polymer Flushing). The decision for borehole cleaning methodology shall be taken at the site based on effectiveness.

B510.3 The cleaning shall be continued till the density of the contaminated drilled mud at the (slurry collected in sampler tube) bottom of pile is less than 1.12 gm/ml

B511 INSTALLATION OF REINFORCEMENT

B511.1 Prefabricated reinforcement cages for piles shall be marked and fitted with spacers to ensure that the cage is correctly orientated and positioned within the pile. Details of the proposed spacers shall be included in the Contractors CWMS for the piling works.

B511.2 The number of joints in longitudinal steel bars shall be kept to a minimum. Joints in reinforcement shall be such the full strength of the bar is effective across the joint and shall be made so that there is no relative displacement of the reinforcement during the construction of the pile.

B511.3 All prefabricated reinforcement cages shall be inspected prior to placement by the Employer. The Contractor shall have his foreman and steel fixer on standby to rectify any unsatisfactory work found during inspection. Any approval of the reinforcement by the Employer shall not relieve the Contractor of his responsibilities and obligations under the terms of the Contract.

B511.4 The reinforcement cage shall be lowered into position only in the daytime after the Employer has accepted the final founding level of the pile and verified the length of the reinforcement cage.

B511.5 Reinforcement protruding above a concreted pile shaft shall be protected against corrosion with cement paste that shall be removed before subsequent construction works commence. If the protection period is longer than a few weeks, weak concrete should be used instead of cement paste.

B512 PLACEMENT OF CONCRETE

B512.1 To prevent segregation, a tube or tremie pipe shall be used to place concrete in all piles. The tremie shall be water-tight throughout its length and have a hopper attached at its head by a water-tight connection.

B512.2 Tremie of 150 mm to 200 mm diameter shall be used for concreting. The tremie should and shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal.

- B512.3 The tremie pipe shall be of sufficient strength and shall have uniform and smooth cross-section inside. The diameter of the tremie shall be large enough in relation to the size of coarse aggregates in the piling concrete. For 20 mm aggregate the tremie pipe shall be of diameter not less than 150 mm and for larger size aggregate diameter of tremie pipe shall not be less than 200mm. All piling above 600mm diameter shall preferably be done using 200mm diameter tremie.
- B512.4 If the hole cannot be practically dewatered, the Employer may permit placement of the concrete under water. The level of the top of the concrete in piles shall be at least 900 mm above the specified cut-off level and after the concrete has hardened; excess concrete shall be removed to the specified cut-off level. Before placing concrete, measures shall be taken such as airlifting and agitation to ensure that there is no accumulation of silt or other loose materials at the base of the bored holes. The Employer may impose other conditions on the placement of concrete under water.
- B512.5 In all cases, the tremie pipe shall be lowered to the bottom of the bore-hole before pouring concrete. The tremie pipe shall always be kept full of concrete and the discharge end shall be maintained below the upper surface of the rising concrete at all times with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.
- B512.6 The placing of concrete shall be a continuous process from the toe level to the top of the pile. Operations that in the opinions of the Employer are likely to disturb or affect the concrete or placing of the concrete shall not be carried out unless agreed by the Employer.
- B512.7 Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting shall be avoided.
- B512.8 The concrete shall be properly graded, shall be self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Sufficient head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.
- B512.9 The diameter of the finished pile shall not be less than that specified and a continuous record shall be kept by the Employer as to the volume of concrete placed in relation to the length cast. To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.
- B512.10 After placing of the concrete from each delivery, the Contractor shall record the volume of concrete deposited and the level of concrete in the pile shaft. The reading shall be plotted in a graph showing the theoretical volume/actual volume and the depth of the concrete placed. This record must be submitted as part of the Contractors quality records for the piling works. For quality check of concrete, concrete cube test on 15 cm cube should be tested at 28 days' strength.
- B512.11 Water to be used for concrete preparation shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities.

- B512.12 The pH value of water shall generally be not less than 6. Admixture of approved quality may be used in order to achieve specific site requirements, such as setting time, early strength etc.
- B512.13 The aggregates to be used as constituent of concrete shall be natural or crushed gravel or crushed rock and free from deleterious material and shall comply with the requirements of IS-383. Aggregates used for concrete shall not be more than 20mm in size for piling.
- B512.14 Concreting of the piles shall be carried out uninterrupted.

B513 CUT-OFF AND CLEAN-UP OF TOP OF PILE

- B513.1 The minimum embedment of cast-in-situ concrete piles into the structure supported by pile shall be provided as per design. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete.
- B513.2 The reinforcement in the pile shall be exposed for full anchorage length to permit it to be adequately bonded into the pile cap. Exposing such length shall be done carefully to avoid damaging the rest of the pile. Defective piles shall be removed or left in place as judged convenient without affecting the performance of adjacent piles or pile cap. Additional piles shall be provided to replace the defective piles.
- B513.3 Pile heads shall be trimmed to the cut-off levels shown in the Drawings within a tolerance of +/-25 mm preferably on the negative side. Details of mechanical tools used in the trimming of pile heads shall be submitted to the Employer for approval as part of the Contractors CWMS for the piling Works to ensure that the concrete at or below the cut-off levels would not be damaged by the trimming operation.

B514 TOLERANCES

B514.1 Permissible Tolerances for Bored Piles

- B514.1.1 Piles shall be installed to within the tolerances specified in this section of the Specifications.
- B514.1.2 Piles which do not comply with the specified tolerances shall not be forcibly corrected and it may be rejected or condemned by the Employer.
- | | |
|---|-------------------|
| (a) Variation in cross-sectional dimensions | : + 50 mm, -10 mm |
| (b) Variation in the final position of the head in plan | : 75 mm |
| (c) Variation of level of top of piles | : +/- 25 mm |

- B514.1.3 Should any pile or piles be out of tolerance or be anticipated to be out of tolerance at the time of incorporation into the Works, the Contractor may request the Employer to modify the design of the structure to accommodate the actual or anticipated position and/or the pile(s) which support a structure between movement joints. The Contractor's request shall include details of the actual position and all the piles which support a structure between movement joints together with the Contractor's assessment of the anticipated position and the piles at the proposed time of incorporation into the structure based on monitoring carried out in accordance with these specifications. Provided that the Contractor has stipulated in his request that he will not make any claim for extension of time or additional monetary compensation of any kind as a result of or in connection with the design modification below and/or any delay or disruption which may result there from. The Employer may, if he considers the request to be practical, indicate his agreement thereto.
- B514.1.4 The Employer shall be under no obligation to agree to any such request or to undertake any such modification and shall not be taken to have agreed to do so unless such agreement is expressly stated in writing. Should the Employer agree to any such request made by the Contractor, the Employer will within a reasonable period modify the design as necessary. The Employer shall be entitled to deduct from monies due to the Contractor the cost of the modification to the design or may recover the same as a debt. Any modification to the design in accordance with this Clause shall not be treated as a variation for any purposes under the Contract and the relevant work shall be measured for payment in accordance with the design as it stood before the making of such modification.
- B514.1.5 Should the actual position of any piles at the time of incorporation into the structure varying by more than 75 mm from the anticipated positions provided by the Contractor, concreting of the structure shall be delayed until process set out above is repeated.
- B514.1.6 Employer shall be entitled to specify any conditions which it requires to be agreed by the Contractor prior to any such request being agreed by the Employer.
- B514.1.7 Modification of the design by the Employer in accordance with this Clause may be subject to the approval of the Employer who may accept the design with conditions in which case the Contractor must comply.
- B514.1.8 The Contractor shall be obliged to continue with the Works with due diligence without regard to and irrespective of any request which may be under consideration pursuant to this Clause. The Contractor shall have no entitlement to any extension of time or to receive any monetary compensation as a result of or in connection with any delay which he may incur as a result of or in connection with any request made pursuant to this Clause or the time which may be taken by the Employer to consider and respond to the same or in connection with any conditions imposed by the Employer all of which shall be at the Contractor's sole risk.

B515 DEFECTIVE PILE

- B515.1 In case defective pile are formed they shall be replaced or left in place wherever is convenient without affecting performance of the adjacent piles or the cap as a whole. Additional pile shall be provided to replace them as directed by Employer. Contractor shall not be paid for the new piles.
- B515.2 Any change in the pile length, diameter, pile cap, defect in concrete forming pile, deviation in reinforcement detailing, and deviation from any other requirement as defined in the specification and drawing etc. shall be termed as defective pile.
- B515.3 Any deviation beyond permissible limits in designed pile location, and alignment etc. shall be noted and adequate measures shall be taken well before the concreting of the pile cap. If the deviation cannot be controlled, pile shall be discarded as directed by the Employer and these piles shall be replaced without any extra cost to the Employer.
- B515.4 Any deviation from the safe load capacity observed during the load test shall be noted and corrective measures shall be taken as directed by the Employer. If the safe load capacity does not meet due to defective test pile construction, the defective test pile shall be replaced with the new test pile without any additional cost.
- B515.5 During chipping of the pile top, manual chipping may be permitted after three days of pile casting; pneumatic tools for chipping shall not be used before seven days after pile casting.
- B515.6 After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

B516 TRIAL PILES FOR LOAD TESTS

- B516.1 In addition to the permanent working piles, the Contractor shall construct Trial Piles.
- B516.2 The exact locations and details of Trial Piles shall be as instructed by the Employer. Trial Piles shall not be incorporated in the completed structure and shall be removed to at least 1000 mm below the proposed cut-off level of the working piles in the vicinity or as otherwise directed by the Employer.
- B516.3 Trial Piles shall be constructed using the materials and methods of construction proposed for the working piles and shall conform to the requirements of these specifications subject to the following additional requirements.
- B516.4 CWMS shall include complete methodology and design for initial pile load testing.
- B516.5 For lateral load test, Inclinator shall be installed along the entire length of the pile at the center and deflection profile along the length of the pile shall be measured.

B516.6 All details of instrumentation for the Trial Piles shall be proposed by the Contractor for acceptance by the Employer as part of the CWMS for the piling works. All instrumentation shall be checked for operation before and after installation, after placement of the reinforcement in the pile bore and after concreting.

B516.7 The piles shall be load tested in accordance with provisions laid down in these specifications. Unless otherwise permitted by the Employer the relevant piling works shall not commence until the construction, testing and records of the Trial Piles have been approved by the Employer.

B517 TESTING OF PILES

B517.1 Static Load Tests

B517.1.1 The minimum 1 number of trial pile for axial load shall be tested for initial load tests at each terminal location and as per the guidelines given in IS2911 part-4.

B517.1.2 The minimum 1 number of trial pile for lateral load shall be tested for initial load tests at each terminal location and as per the guidelines given in IS2911 part-4. The sufficient number of reaction piles shall be casted to ensure the lateral loading of the pile.

B517.1.3 After test pile installation, piles shall be tested under static as well as dynamic compression load as directed by the Employer. There shall be two categories of test on piles, namely, Initial Load Tests and Routine Load Tests. Initial Load Tests shall be carried out on Trial Piles which are not to be incorporated as part of structure. Routine Load Tests shall be carried out as a check on working piles.

B517.1.4 Pile load tests shall be carried out in accordance with the requirements of these specifications as follows;

- (a) Initial Load Tests shall be carried out on all Trial Piles to a maximum load of 2.5 times the working load of the most heavily loaded working pile to which the trial pile relates;
- (b) Routine Load Tests shall be carried out on not less than 2 in number but not more than 2 percent depending upon the number of piles of all working piles for the related structure to a maximum of 1.5 times the working load of the working pile and as per table given below;

Total No. of Piles in Berth Structure	Number of Tests
Up to 50	2
51 to 150	3
Beyond 150	2% of total working piles (fractional number rounded to next higher integer number)

- B517.1.5 Routine Load Tests shall be distributed evenly throughout the works so as to provide adequate data in support of the proposed pile founding levels for all piles. The Contractor shall propose the distribution and scheduling of routine pile load tests to the Employer for acceptance as part of his CWMS for the piling works.
- B517.1.6 Load tests shall be carried out by the Contractor in the presence of the Employer under the direction of a qualified and experienced Contractor's Engineer who shall record the results.
- B517.1.7 All equipment's to be used for load test shall be calibrated to the design test load and a recent calibration test certificates of all equipment's shall be certified from IIT / any government Institutions and shall be submitted to Employer for approval.
- B517.1.8 The Contractor shall submit for the approval of the Employer details of the test procedure that he proposes to adopt, together with full details of the reaction/ anchor, supports, measurement devices etc. as part of his CWMS for the piling works. The method and procedures for static load tests to determine the settlement of the pile under load shall generally conform with the requirements of IS: 2911 (Part-4) and IS 14593 except as modified in these specifications.
- B517.2 Concrete Cores from Piles
- B517.2.1 Concrete cores from concrete piles shall only be taken when instructed by the Employer. The positions from which the cores are taken shall be as instructed by the Employer.
- B517.2.2 Where required, concrete cores shall be of 100mm diameter and the method of taking concrete cores shall be in accordance with relevant Indian Standards else specified in this specification. Holes formed by taking concrete cores from piles shall be reinstated using an approval concrete mix or an approved grout mix.
- B517.2.3 Each concrete core from a pile shall be inspected for evidence of segregation of the constituents and for the presence of voids. Specimens selected from each core shall be tested to determine the compressive strength.
- B517.2.4 The method of preparing, inspecting and testing concrete cores shall be as per specification of Concrete given in these tender specifications.
- B517.2.5 If the result of any test on a concrete core from a pile does not comply with specified strength, additional cores shall be taken from the same pile and additional tests shall be carried out.
- B517.2.6 Additional concrete cores shall be 100mm diameter for concrete of 20mm nominal maximum aggregate size and 150mm diameter for concrete of 40mm nominal maximum aggregate size. The number of additional cores shall be as instructed by the Employer.

- B517.2.7 If the result of any additional test does not comply with the compliance criteria for concrete cores the Contractor shall submit remedial proposals to the Employer for approval. The number of additional piles and additional tests shall be as instructed by the Employer.
- B517.3 Integrity Testing
- B517.3.1 Integrity testing of piles shall be carried out for atleast 5% of the total piles. The piles where the testing is to be carried out shall be indicated by the Employer. Non-destructive integrity test shall comply with IS 14893. The Contractor shall submit the proposed procedures and details of proposed testing equipment for Integrity testing to the Employer for approval at least 7 days before concreting.
- B517.3.2 The Contractor shall submit the following information to the Employer at least two weeks before testing:
- (a) The name and address of the proposed independent testing organisation;
 - (b) Qualifications and experience of the organisation 's staff to be employed in carrying out and interpreting the testing;
 - (c) Written evidence of the organisation's recent experience of undertaking the specified type of testing on similar projects;
 - (d) One copy of the proposed test report form;
 - (e) A method statement for each type of test proposed.
- B517.3.3 Non-destructive integrity tests shall be carried out by an independent Testing Firm as approved by the Employer. The Contractor shall provide attendance and other preparatory works as required. The Contractor shall provide the Testing Firm with a copy of the ground investigation report, a Site plan showing bore hole locations and pile layout and a list of the piles to be tested with the date of concreting, total length, length of casing (if any), diameter and volume of concrete used plus any other relevant information required for the testing of the pile.
- B517.3.4 The methodology for Integrity testing should be in accordance with relevant Indian Standard else specified in this specification. The interpretation of test shall be carried out by competent persons and the full test results and findings shall be given to the Employer within 10 days of the completion of each phase of testing.
- B517.3.5 The Contractor shall submit the initial test results, which shall include a copy of the field data obtained during the testing but exclude detailed analysis, to the Employer within 24 hours of the completion of the test.

- B517.3.6 All tests shall be carried out under the direction of an experienced and competent supervisor conversant with the test procedure and acceptable to the Employer. All personnel operating the test equipment shall have been trained in its use.
- B517.3.7 The Contractor shall not carry out any testing of a concrete pile until at least 14 days after it has been cast and shall ensure that damage does not occur to complete piles.
- B517.3.8 Integrity testing shall be carried out progressively as piling is completed and in sufficient time before the relevant piling works obstructs access to carry out the test. The results of integrity tests shall be used to enable the Employer to select piles for further testing.
- B517.3.9 The testing organization shall examine and interpret the results in detail and prepare a report on the tests. The report shall be submitted to the Employer within 10 days of completion of the testing, and shall contain information in accordance with the following schedule where applicable:
- (i) Contract name and number
 - (ii) Contract location
 - (iii) Pile reference number
 - (iv) Pile type and size
 - (v) Pile toe level
 - (vi) Total length of pile
 - (vii) Length of pile from instrumentation location to Toe
 - (viii) Working load
 - (ix) Date of pile installation
 - (x) Date of test
 - (xi) Cube strength of pile concrete
 - (xii) Penetration of pile below commencing surface
 - (xiii) Identification of supervisor
 - (xiv) Identification of person carrying out the analysis
 - (xv) An interpretation of each record
 - (xvi) A review of any anomalies in terms of influence of poor materials or workmanship during pile construction.
- B517.3.10 Any deviation in the record from that which would be expected from a sound pile without defect shall be reported. The report shall indicate the nature, location and severity of the defect and recommendations shall be made for further testing. Where possible, the implication of the existence of the defect on the performance of the pile shall be evaluated.
- B517.3.11 If the result of any integrity test on a pile does not comply with the specified requirements, additional tests shall be carried out. The number of additional tests shall be as instructed by the Employer.

B517.3.12 In the event that any anomaly is found in the results of such testing, the Employer may call for further testing to be carried out or for the relevant part of the pile to be exposed where practicable for inspection, in order to investigate the cause, nature and extent of the anomaly and whether the pile is satisfactory for its intended use.

B518 RECORDS OF PILING WORKS

B518.1 General

B518.1.1 Records of each cast-in-situ piles shall be signed by the Employer after he has carried out the inspection/verification personally.

B518.1.2 Records of piling shall be kept by the Contractor on the Site and submitted to the Employer within 24 hours after the driving or installation of each pile has been completed. The records shall be kept on standard forms as submitted with the Contractors CWMS and agreed with the Employer.

B519 RECORDS OF GROUND STATE

B519.1 During excavation the Contractor shall keep a record of the nature of the ground including the levels of changes in strata, a description of the soil encountered and the depth, thickness and nature of any boulders or other obstructions.

B519.2 When directed by the Employer disturbed samples of the soil shall be taken and kept in screwed top sample jars marked with the pile number and depth from which the samples are taken. Such samples shall be kept on site until such time as the Employer may direct.

B520 RECORDS OF LOAD TESTS

B520.1 Records of load tests on piles shall be kept by the Contractor on the Site and a report shall be submitted to the Employer within 48 hours after the test has been completed. The records shall be kept on standard forms as submitted with the Contractors CWMS and agreed with the Employer. The records shall include graphs showing load and settlement versus time, plotted in the format shown in BS 8004, Figure 15(a) or equivalent IS.

B521 PILING RECORDS

B521.1 The Contractor shall keep a record of the following data (as applicable) and keep daily record sheets signed by the Contractor's representative and submit these to the Employer each week, or on completion of each pile, whichever is more frequent. The format of the records shall be as submitted with the Contractors CWMS and agreed with the Employer.

- (i) Date and time of installation;
- (ii) Weather condition including significant wave height and direction of approach;
- (iii) Pile serial reference number and size;
- (iv) Type of work carried out;
- (v) Length of pile/tube or casing used;
- (vi) Seabed/ground CD level at pile position;
- (vii) Actual position of pile as constructed;

- (viii) Pile vertical and horizontal deviations, if any;
- (ix) Gross and net lengths or depth of casing driven and pile bored;
- (x) CD level of top or bottom of pile after completion of piling;
- (xi) Depth concreted and mix and volume of concrete placed and time of start and completion of concreting;
- (xii) Details of reinforcement;
- (xiii) Details of sub-soil strata and ground water encountered in boring;
- (xiv) Detail of obstructions and delays or interruptions and actions taken;
- (xv) Accurate records of any tests; and
- (xvi) Any other relevant data requested by the Employer.

B521.2 The Contractor shall prepare and maintain a piling record plan throughout the works. The piling record plan shall be updated progressively based on the pile completed and shall be submitted to the Employer weekly throughout the piling works. The piling record plan(s) shall include:-

- (i) Location of each pile and its size,
- (ii) C.D. levels of the top and bottom of each pile;
- (iii) C.D. cut-off level of each pile;
- (iv) Ground level at the pile position;

B522 TESTS AND STANDARDS OF ACCEPTANCE

B522.1 The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

B522.2 The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

B522.3 Condemned or Rejected Piles

B522.3.1 If at any time, any piles are found to be in any way unsatisfactory or out of position, they will be condemned. The Contractor shall provide new sound piles and carry out any other additional works, generated by the remedial work at his own expense.

B522.3.2 In the event that changes due to defective pile such as these are necessary the Contractor shall compensate the Employer for the extra costs involved, including the following:

- (i) Payment for extra design or checking costs if design is carried out by the Employer;
- (ii) Payment for extra cost of foundation(s) and the associated testing;
- (iii) Compensation for liquidated and ascertained damages for the delay.

B600 FORMWORK

B601 GENERAL

B601.1.1 Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Employer, together with all props, staging, centering, scaffolding and temporary construction required for their support. The design, erection and removal of formwork shall conform to IS 14687: Falsework for Concrete Structures - Guidelines.

B602 MATERIALS

B602.1 General

B602.1.1 All materials shall comply with the requirements of IRC: 87/MORTH. Materials and components used for formwork shall be examined for damage or excessive deterioration before use/re-use and shall be used only if found suitable after necessary repairs. In case of timber formwork, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits.

B602.1.2 Forms shall be constructed with metal or marine plywood. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Adjustable steel props can be used as support for forms

B603 DESIGN OF FORMWORK

B603.1 General

B603.1.1 The Contractor shall furnish the design and drawing of complete formwork (i.e. the forms as well as their supports) for approval of the Employer before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information to the Employer for approval.

B603.1.2 Notwithstanding any approval or review of drawing and design by the Employer, the Contractor shall be entirely responsible for the adequacy and safety for formwork.

B603.1.3 The design of the formwork shall conform to provisions of IS 14687. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection

B604 WORKMANSHIP

B604.1 General

B604.1.1 The formwork shall be robust and strong and the joints shall be leak-proof.

B604.1.2 Balli shall not be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Staging shall be provided with an appropriately designed base plate resting on firm strata.

- B604.1.3 The number of joints in the formwork shall be kept to a minimum by using large size panels. The design shall provide for proper “soldiers” to facilitate alignment. All joints shall be leak proof and must be properly sealed. All joints in formwork shall be sealed with PVC JOINT sealing tapes, foam rubber or PVC T-section to prevent leakage of grout.
- B604.1.4 As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be withdrawn easily. Use of double headed nails shall be preferred.
- B604.1.5 Use of through ties shall not be permitted for any structures in “Extreme” exposure class.
- B604.1.6 The use of through ties for other structures shall be restricted, as far as practicable. Wherever ties are used shall be used with HDPE sheathing so that the ties can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.
- B604.1.7 The chamfers, beveled edges and mouldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as per drawing and as directed by the Employer.
- B604.1.8 Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing of concrete.
- B604.1.9 The formwork shall be constructed with pre-camber to the soffit to allow for deflection of the formwork. Pre-camber to allow for deflection of formwork shall be in addition to that indicated for the permanent structure in the drawings unless noted otherwise.
- B604.1.10 Where centering trusses or launching trusses are adopted for casting of superstructure, the joints of the centering trusses, whether welded, riveted or bolted should be thoroughly checked periodically. Also, various members of the centering trusses should be periodically examined for proper alignment and unintended deformation before proceeding with the concreting. They shall also be periodically checked for any deterioration in quality due to steel corrosion.
- B604.1.11 The formwork shall be made so as to produce a finished concrete true to shape, line and levels and dimensions, subject to the tolerances specified in respective sections of these specifications, or as directed by the Employer.
- B604.1.12 Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.

- B604.1.13 Forms shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration during and after placing the concrete.
- B604.1.14 The formwork shall take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures, having regard to the deformation of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes.
- B604.1.15 Suitable camber shall be provided to horizontal members of structure, especially in long spans to counteract the effects of deflection. The formwork shall be so fixed as to provide for such camber.
- B604.1.16 All formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating (machine oils) shall be prohibited for use as coating or releasing agent.

B605 FORMED SURFACE AND FINISH

- B605.1 The formwork shall be lined with material approved by the Employer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and so fixed to its backing as not to impart any blemishes. It shall be of the same type and obtained from only one source throughout for the construction of any one structure.
- B605.2 The surface finish of all concrete works shall be assessed in accordance with AS3610. The required surface finish shall be as follows:
- (i) Class 2: All vertical faces of Land structures;
 - (ii) Class 3: All other concrete works
- B605.3 The contractor shall make good any imperfections in the resulting finish as required by the Employer. Internal ties and embedded metals parts shall be carefully detailed, and their use shall be subject to the approval of the Employer.

B606 PRECAUTIONS

- B606.1 Special measures in the design of formwork shall be taken to ensure that it does not hinder the shrinkage of concrete. The soffit of the formwork shall be so designed as to ensure that the formwork does not restrain the shortening and/or hogging of beams. The forms may be removed at the earliest opportunity to the minimum time for removal of forms with props retained in position.
- B606.2 Where necessary, formwork shall be so arranged that the soffit form, properly supported on props only can be retained in position for such period as may be required by maturing conditions.
- B606.3 Any cut-outs or openings provided in any structural member to facilitate erection of formwork shall be closed with the same grade of concrete as the adjoining structure immediately after removal of formwork ensuring watertight joints.
- B606.4 Provision shall be made for safe access on, to and about the formwork at the levels as required.

B606.5 Close watch shall be maintained to check for settlement of formwork during concreting.

B606.6 Any settlement of formwork during concreting shall be promptly rectified.

B606.7 Water used for curing should not be allowed to stagnate near the base plates supporting the staging and should be properly drained.

B607 PREPARATION OF FORMWORK BEFORE CONCRETING

B607.1 The inside surfaces of forms shall, except in the case of permanent form work or where otherwise agreed to by Employer be coated with a release agent supplied by approved manufacturer or of an approved material to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not allowed to come into contact with any reinforcement. Different release agents shall not be used in formwork for exposed concrete.

B607.2 Before re-use of forms, the following actions shall be taken:

- (i) The contact surfaces of the forms shall be cleaned carefully and dried before applying a release agent.
- (ii) It should be ensured that the release agent is appropriate to the surface to be coated. The same type and make of release agent shall be used throughout on similar formwork materials and different types should not be mixed.
- (iii) The form surfaces shall be evenly and thinly coated with release agent. The vertical surface shall be treated before horizontal surface and any excess wiped out.
- (iv) The release agent shall not come in contact with reinforcement or the hardened concrete.

B607.3 All forms shall be thoroughly cleaned immediately before concreting with compressed air.

B607.4 The Contractor shall give the Employer due notice before placing any concrete in the forms to permit him to inspect and approve the formwork, but such inspection shall not relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

B608 TOLERANCES

B608.1 Except where otherwise noted on the Drawings, formwork shall be designed and constructed such that concrete surfaces shall be formed within the tolerances specified for the completed structural concrete elements of these specifications. Where tolerances conflict, the lesser tolerance shall be adopted.

B608.2 The dimensions lines, levels and grades of the formwork shall be checked by the Contractor immediately prior to the placing of the concrete and again immediately after placement of concrete.

B609 REMOVAL OF FORMWORK

B609.1 The scheme for removal of formwork (i.e. de-shuttering and de-centering) shall be planned in advance and furnished to the Employer for scrutiny and approval. No formwork or any part thereof shall be removed without prior approval of the Employer.

B609.2 The formwork shall be so removed as not to cause any damage to concrete. Centering shall be gradually uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

B609.3 Where not specifically approved, the time of removal of formwork (when ordinary Portland Cement is used without any admixtures at an ambient temperature exceeding 10 degrees Celsius) shall be as under:

(a)	Walls, abutments, columns and vertical faces of structural	: 12 to 48 hours as may be decided by Employer
(b)	Soffits of Slabs (with props left under)	: 3 days
(c)	Props (left under slabs)	: 14 days
(d)	Soffit of beams (with props left under)	: 7 days
(e)	Props (left under beams)	: 21 days
(f)	Cantilever Construction	: Formwork shall remain till structures for counteracting or bearing down have been erected & have attained sufficient strength (minimum 14 days).

B609.4 Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set, in order to avoid cracking due to shrinkage of concrete.

B610 RE-USE OF FORMWORK

B610.1 When formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such examination shall always be carried out before being used again. Before re-use all components shall be cleaned of deposits of soil, concrete or other unwanted materials. Threaded parts shall be oiled after cleaning.

B610.2 All bent steel props shall be straightened before re-use. The maximum deviation from straightness is 1/600 of the length. The maximum permissible axial loads in used props shall be suitably reduced depending upon their condition. The condition of the timber components, plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

B611 SPECIALISED FORMWORK

- B611.1 Specialized formwork may be required in the case of, underwater concreting, segmental construction etc. Such specialized formwork shall be designed and detailed by competent agencies and a set of complete working drawings and installation instructions shall be supplied to the Employer for approval. The site personnel shall be trained in the erection and dismantling as well as operation of such specialized formwork. In case proprietary equipment is used, the supplier shall supply drawings, details, installation instructions, etc., in the form of manuals along with the formwork. Where specialized formwork is used, close co-ordination with the design of permanent structure is necessary.
- B611.2 In order to verify the time and sequence of striking/removal of specialized formwork, routine field tests for the consistency of concrete and strength development are mandatory and shall be carried out before adoption.
- B611.3 For specialized formwork, the form lining material may be either plywood or steel sheet of appropriate thickness. Plywood is preferred where superior quality of surface is desired, whereas steel sheeting is normally used where large number of repetitions is involved.

B612 TEST AND STANDARDS OF ACCEPTANCE

- B612.1 The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.
- B612.2 The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.
- B612.3 MORTARS

B613 CEMENT

B613.1 Standard

- B613.1.1 Cement to be used in the Works shall be conforming to the following IS standards codes-
- 53 Grade Ordinary Portland Cement: IS 8112
 - Portland Pozzolana Cement (fly ash based): IS 1489 (part-I)

B614 SUPPLY & STORAGE

- B614.1 The cement to be used on works shall be OPC or PPC (fly ash based) as specified. Unless otherwise specified, Ordinary Portland Cement or PPC shall be supplied in bags containing 50 Kg. each. Stacking of cement rejected due to aging or not fulfilling IS requirements shall be at the cost of the Contractor. The Cement held in storage for a period more than 90 days shall be tested before its use, if directed by Employer. A common cement register shall be kept at site office showing the supply, stock and issue on a daily basis. Contractor will have to make his own arrangements for storage of cement which shall meet the requirements of IS 4082.

B615 TESTS

- B615.1 A certified report, attesting the conformance of the cement to IS Specifications by the cement manufacturer shall be furnished to the Employer, by the contractor.
- B615.2 Samples of cement shall be taken immediately on receipt of cement at site. The methods and procedure of sampling shall be as per IS 3535. Tests shall be carried out for fineness, initial and final setting time and compressive strength as per IS 4031.
- B615.3 Supplier of cement shall furnish the following documents before the cement is delivered to site:
- (a) Certificate conforming that chemical composition and physical characteristics are within the stipulated values for types of cement supplied as per relevant codes.
 - (b) Certificate conforming that the chloride content in the cement is not in excess of 0.05 percent of mass of cement.
- B615.4 If during subsequent testing of cement supplied in lots any of the properties are found to be outside the acceptable limits, the lot of cement shall be rejected.
- B615.5 Each 1000 bags or part thereof, of cement or each wagon load of cement shall constitute one lot of cement for the purpose of conducting tests at site.
- B615.6 Samples for testing at site shall be taken at random from 2% of the total quantity supplied in one lot. For cement supplied in bags, samples shall be drawn from minimum of 5 bags and the for bulk cement, sampling shall be done with the help of slotted sampler to be as per IS 3535.
- B615.7 Results of test conducted on samples drawn shall be submitted to the Employer for his approval. If in the opinion of the Employer, the test results are not within permissible limits, the lot of cement from which samples have been obtained for testing shall stand rejected and the material shall be removed from site.
- B615.8 Following tests shall be conducted at site on each lot of cement delivered:

Mandatory Tests	Number of Test per Lot
Consistency of standard cement paste	5
Initial and final setting time	5 each
Compressive strength test	10
Fineness Test & Soundness Test	5

- B615.9 Mean values of the results from the above results shall be taken as the representative value and the acceptance criteria shall be based on these tests. All test procedures and computation of test results shall be as per IS 4031.

B615.10 Apart from mandatory tests specified as above, the Employer may at his discretion, call for any additional tests that he may consider necessary. All such tests shall be done on representative samples taken from each lot described above and testing and computation of test results shall be done as per IS 4031. Charges for such testing shall be borne by the contractor.

B616 FINE AGGREGATE

B616.1 Standard

B616.1.1 Fine aggregate for different end uses (other than light weight concrete) shall conform to the following standards:

For Structural Concrete - IS: 383 (between Grading Zones I & II)

For Mortar & Grout - IS: 2116

For Plastering - IS: 1542 (Class A grading)

B616.1.2 Fine aggregate shall consist of natural sands or machine crushed rock/gravel. It shall be clean, sharp, hard, strong and durable and free from dust, vegetable substances, adherent coating, clay, loam, alkali, organic matter, mica, soluble sulphate, gypsum or any other deleterious substances which can be injurious to the setting qualities / strength / durability of concrete. Use of sea sand is prohibited.

B616.2 Source

B616.2.1 Once a specific source of supply of fine aggregate is accepted, the source shall not be changed without prior approval of the Employer.

B616.3 Storage

B616.3.1 Fine aggregates shall be stored at site in adequate quantity on clean and well maintained hard floor and areas not liable to flooding. Contamination with foreign matter and earth shall be avoided during storage and while heaping the materials.

B616.4 Usage

B616.4.1 Fine aggregate shall be thoroughly washed at site with clean fresh water such that the percentage of all deleterious matter is within the permissible limits as laid down in IS 2386 (Part-II).

B616.4.2 Screening of sand shall be done if necessary, and as and when directed by the Employer to remove all objectionable foreign matter and effecting any grading.

B617 WATER

B617.1 Standard

B617.1.1 Water supplied shall conform to the various provisions detailed under Clause 5.4 of IS 456:2000. Broadly stated water used for mixing and curing as also for cooling / washing of aggregates shall be clean and fresh, free from oils, acids, alkalizes, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Sea water or water from excavation shall not be used.

B617.1.2 Potable water is generally considered satisfactory for mixing concrete. As a guide the following concentration represent the maximum permissible values:

B617.1.3 To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The test shall be conducted as detailed in 8.1 of IS 3025 (Part 22).

B617.1.4 To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H₂SO₄. The test shall be conducted as detailed in 8 of IS 3025 (Part 23)

B617.1.5 Permissible limits for solid content shall be as given in the table below:

S. No.	Particulars	Tested as per	Permissible limits (Max)
i.	Organic	IS 3025 (Part 18)	200 mg/l
ii.	Inorganic	IS 3025 (Part 18)	3000 mg/l
iii.	Sulphates (as SO ₃)	IS 3025 (Part 24)	400 mg/l
iv.	Chlorides (as Cl)	IS 3025 (Part 32)	2000 mg/l for concrete not consisting embedded steel & 500 mg/l for reinforced concrete work
v.	Suspended matter	IS 3025 (Part 17)	2000 mg/l

B617.2 Storage

B617.2.1 Water shall be so stored that it remains free from all deleterious materials as mentioned above.

B617.3 Tests

B617.3.1 No water shall be used until tested for its chemical and other impurities in accordance with IS 3025 to ascertain its suitability. Tests shall be conducted whenever the source is changed or during seasonal variation.

B618 FLY ASH

B618.1 Material

B618.1.1 Fly ash is a finely crushed residue resulting from the combustion of pulverized coal in boilers. Fly ash used shall be as per IS: 3812-1981. It shall be clean and free from any contamination of bottom ash, grit or small pieces of pebbles. Fly ash adding is meant for use to improve grading of its pozzolanic properties. Grades and proportion of fly ash shall be as specified in the item description in accordance with relevant IS provision. It is obligatory on the part of supplier/manufacturer that the fly ash conforms to the requirement if mutually agreed & shall furnish a certificate to this effect to the employer or his representative.

B618.1.2 Fly ash shall be protected from dirt collecting on it.

B619 MORTAR MIXING

B619.1 Cement and sand in the specified proportions shall be mixed in dry thoroughly by using mechanical mixer or by hand mixing, if permitted. Composition (cement and sand mortar, or lime and sand mortar or cement, lime and sand mortar) and proportions of mortars shall be as specified in the respective items of work. The ingredients of the mortar shall be accurately gauged by measure. Compressive strength test / cube test for mortar shall be done for every 10m³ of mix as per IS 4031. Charges for all the required tests shall be borne by the contractor.

B619.2 Precaution

B619.2.1 Mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.

B700 PLAIN CEMENT CONCRETE (PCC) WORKS

B701 CEMENT

B701.1 **Cement shall be as specified under –Mortars specifications**

B702 AGGREGATE

B702.1 Coarse Aggregates

B702.2 Standard

B702.2.1 Coarse aggregate for use in concrete (other than light weight concrete) shall conform to IS 383.

B702.2.2 Coarse aggregate shall have a minimum specific gravity of 2.6 (saturated surface dry basis). Aggregate below this specific gravity shall not be used without specific permission of the Employer.

B702.2.3 Coarse aggregate shall consist of natural or crushed stone, angular in shape with granular or crystalline surfaces or approved river shingle or gravel, rounded in shape. All aggregate shall be clean and free from elongated, friable, flaky or laminated pieces, adherent coatings, clay lumps, mica, organic matter and any other deleterious matter that may cause corrosion of reinforcement or impair the strength and/or durability of concrete. It shall be chemically inert, hard, strong, dense, and durable against weathering.

B702.2.4 The maximum quantities of deleterious materials in the coarse aggregate shall not exceed the limits indicated in the IS 383 when tested as per IS 2386 Part-I & Part-II “Method of Tests for Aggregate for Concrete”.

B702.3 Source

B702.3.1 Once a specific source of supply of coarse aggregate is accepted, the source shall not be changed without prior approval of the Employer.

B702.3.2 Supplier of aggregates shall furnish the following information before the material is delivered to site:

B702.3.3 Precise location of source from where the material is to be supplied

B702.3.4 Trade group of principal rock type as per table given below

B702.3.5 Presence or reactive minerals.

Trade group names of aggregate	Granite, Gabbro, Dolerite, Rhyolite
To be used for concrete	Basalt, Quartzite, Gneiss

The supplier shall also furnish reports of test results giving the following information for approval to Employer before delivery of material at site:

- (a) Specific gravity
- (b) Bulk density
- (c) Moisture content
- (d) Absorption value
- (e) Aggregate crushing strength
- (f) Aggregate impact value

- (g) Abrasion value
- (h) Flakiness index
- (i) Elongation index
- (j) Limits of deleterious substances in the aggregate
- (k) Soundness of aggregate
- (l) Potential reactivity of aggregates.

B702.4 Storage

- B702.4.1 Coarse aggregate of available sizes shall be stored at site as separate stacks over clean and well maintained hard floor and areas not liable to flooding. Alternatively, they will be stored in bins.
- B702.4.2 Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. It shall be kept in layers not exceeding 1.2 m in height to prevent coning or segregation.

B702.5 Usage

- B702.5.1 Coarse aggregate, which is not clean, shall be washed with clear fresh water before use in the job. Screening would be done if considered necessary by the Employer without extra cost.

B702.6 Tests

- B702.6.1 All test shall be conducted in accordance with IS 2386 (Part I to VIII).
- B702.6.2 In addition to above, the following tests shall be carried out on representative samples from every lot of aggregates after delivery at site. These test results are to be submitted to the Employer for his approval. Acceptance criteria for aggregates shall be based on the results of this set of tests only. If in the opinion of the Employer, the test results are not within permissible limits, the lot of aggregates from which the samples have been obtained for testing shall stand rejected and the material shall be removed from the site.
- B702.6.3 Mandatory Tests on Aggregates at site shall be min. 3 on each 10 cum or part there of as per IS: 2386. Mean value of the results from site test shall be taken as the representative value and the acceptance criteria shall be based on these. All test procedures & computations for test results shall be as per IS 2386.
- B702.6.4 Apart from above, the Employer may at his discretion, call for any additional tests that he may consider necessary. Sampling, procedure and computations for such test shall be done in accordance with IS 2430 and IS 2386 as applicable.

B702.7 Fine Aggregates

- B702.7.1 Fine aggregates shall be as specified under – Mortars specifications.

B702.8 Water

- B702.8.1 Water shall be as specified under – Mortars specifications.

B702.9 Admixtures

B702.9.1 Admixtures if required shall be as specified under Structural Concrete specifications.

B702.10 Placing of Cement Concrete

B702.10.1 Placing of cement concrete shall be as specified under-Reinforced Cement Concrete specifications (relevant as applicable). All concrete shall be protected against damage until final acceptance by the Employer.

B800 STRUCTURAL CONCRETE

B801 DESCRIPTION

B801.1 General

B801.1.1 The work shall consist of furnishing and placing structural concrete and incidental construction in accordance with these specifications and in conformity with the lines, grades and dimensions, as shown on the drawings or as directed by the Employer.

B801.2 Construction Work Method Statement

B801.2.1 The Contractor shall submit a Construction Work Method Statement (CWMS) for all concrete works in accordance with the general requirements as specified in the specifications and incorporating all additional detailed technical requirements as specified in this section.

B801.2.2 In broad terms, the Contractors CWMS for concrete works shall include but not be limited to the following items subject to the additional technical requirements for concrete works as specified herein:

- (a) Description of overall concrete works construction sequence and programme including trial mix production and testing;
- (b) Details of methods for the production of concrete for the Works including but not limited to, details of the following;

Material Constituents

- (i) Description and source of all constituent materials;
- (ii) Material test results or certificates demonstrating conformance of the constituents to the requirements of these specifications;

Concrete Mixes (for each concrete mix proposed for use)

- (iii) Description of each concrete mix and proposed usage in the Works;
- (iv) Target batch weights in kg/m³ for all constituents;
- (v) Design total water content in L/m³;
- (vi) Actual combined grading curve and design combined grading curve for all standard IS sieve sizes presented in cumulative % passing;

(vii) Trial mix slump and corresponding nominated slump;

Batching, Mixing and Transport

- (viii) Details of the concrete batching plant where the concrete is to be mixed;
 - (ix) If concrete is to be supplied by an external supplier from an offsite batching plant, statement from the supplier guaranteeing that the concrete can be supplied to the site at sufficient rate and in sufficient quantity to permit uninterrupted placement of concrete on site;
 - (x) Level of control and accuracy of batching;
 - (xi) Level of control and accuracy of determination of the aggregate moisture content;
 - (xii) Minimum mixing and discharging time.
- (c) Details of construction methods for the placement of concrete in the works, including but not limited to details as follows;
- (i) Details of labour, plant and equipment to be utilised;
 - (ii) provision of safe access and sufficient lighting for concreting works;
 - (iii) Measures for the limiting and controlling maximum curing temperatures and temperature differentials;
 - (iv) methods of placement and compaction of concrete;
 - (v) methods of finishing unformed surfaces;
 - (vi) measures for the prevention of plastic shrinkage or settlement cracking and actions to be taken in the event that these are observed;
 - (vii) methods of curing including details of any products proposed; and
 - (viii) any safety, environmental or other controls to be employed;
- (d) Contingency plans or procedures to be employed in the event of unforeseen interruption of concrete works due to adverse weather, batch plant breakdown, or other malfunction;
- (e) Details of inspection, test methods and analysis or calculations to be undertaken to ensure conformance of the concrete works with the requirements of these specifications (including relevant ITPs and proforma pre-pour checklists);
- (f) Details of methods for rectification in the event of non-conformance of either materials of construction requirements of these specifications including details of concrete repair methods and proprietary products;

- B801.2.3 Depending on the Contractors proposed sequence and programme of works, and subject to the agreement of the Employer, the Contractor may choose to either submit a single CWMS covering all concrete works under the Contract, or a number of CWMSs covering the individual sections of the concrete works.
- B801.2.4 Irrespective, the Contractor shall submit his CWMS for approval at least 42 days prior to the intended date for first commencement of the concrete works to which the CWMS refers. The Employer will take maximum 7 days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.
- B801.2.5 The resolution of such comments on the CWMS submission to the satisfaction of the Employer and the Employer's subsequent approval of the CWMS shall constitute a HOLD POINT on the commencement of the concrete works to which the CWMS refers.
- B801.3 **Notification of Concrete Placement and Weekly Reporting**
- B801.3.1 The Contractor shall give at least 24 hours advance notice to the Employer prior to his intended commencement of concrete placement in the works to enable the Employer or his representative to inspect the installed reinforcement and any cast-in fitments.
- B801.3.2 The inspection and acceptance of the installed reinforcement and any cast-in fitments by the Employer shall constitute a HOLD POINT on the placement of concrete in that section of the Works.
- B801.3.3 The placement of concrete in the Works shall constitute a WITNESS POINT for the Employer or his delegated representative.
- B801.3.4 The Contractor shall submit to the Employer each week his working programme for the concrete works scheduled for the following week including a breakdown of activities planned for each day such that the Employer can coordinate his inspection of the works.
- B802 MATERIALS**
- B802.1 **Cement**
- B802.1.1 Cement to be used in the works shall be any one of the following types with the prior approval of the Employer:
- (a) Ordinary Portland Cement, 53 Grade, conforming to IS: 12269.
 - (b) Portland Pozzolana Cement, conforming to IS: 1489 Part I and II

- B802.1.2 Cement conforming to IS: 12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS: 456 are sulphate concentration in excess of 0.2 percent in soil sub-strata or 300 ppm (0.03 percent) in ground water. Tests to confirm actual values of sulphate concentration are essential when the structure is located near the sea coast, chemical factories, and agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS: 12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 540 kg/cum of concrete.
- B802.1.3 Cement conforming to IS: 8041 shall be used only for precast concrete products after specific approval of the Employer.
- B802.1.4 Total chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total Sulphur content calculated as sulphuric anhydride (SO₃) shall in no case exceed 2.5 percent and 3.0 percent when tri-calcium aluminate percent by mass is up to 5 or greater than 5 respectively.
- B802.1.5 Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high as per IS 4082. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.
- B802.1.6 Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the Contractor without charge to the Employer.
- B802.1.7 The Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Employer at all times.
- B802.1.8 The Contractor shall make a monthly return to the Employer on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

B802.2 Coarse Aggregates

- B802.2.1 For plain and reinforced cement concrete (PCC and RCC) coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali-silica reaction shall not be used. All coarse aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, Parts I to VIII.
- B802.2.2 The contractor shall submit for the approval of the Employer, the entire information of making aggregates from quarry stones. Further reference to conform in line with Appendix A of IS: 383.
- B802.2.3 Maximum nominal size of coarse aggregate for various structural components in PCC, RCC shall conform to Section 9B902.1
- B802.2.4 The maximum value for flakiness index for coarse aggregate shall not exceed 35 percent. The coarse aggregate shall satisfy the following requirements of grading:

IS Sieve Size	Percent Weight Passing the Sieve		
	40 mm	20 mm	12.5 mm
63 mm	100	-	-
40 mm	95-100	100	-
20 mm	30-70	95-100	100
12.5 mm	-	-	90-100
10 mm	10-35	25-55	40-85
4.75 mm	0-5	0-10	0-10

- B802.2.5 Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard, levelled and well drained. If necessary, the ground shall be covered with 50 mm plank. The total amount of deleterious/ foreign materials shall not exceed 5% by weight according to IS 383-1970. If the contamination is found to be exceeding the limit, the stone metal shall be screened and washed before using.
- B802.2.6 Coarse aggregates, unless otherwise agreed by the Employer in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more). Aggregates placed directly on the ground shall not be removed from the stockpile within 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

B802.3 Sand/Fine Aggregates

B802.3.1 For plain and reinforced cement (PCC and RCC) concrete works, fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorized sand washing machines should be used for screening and removal of foreign material, pebbles and other material from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Employer the entire information indicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

B802.3.2 Sand/fine aggregate for structural concrete shall conform to the following grading requirements:

IS Sieve Size	Percent by Weight Passing the Sieve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 microns	15-34	35-59	60-79
300 microns	5-20	8-30	12-40
150 microns	0-10	0-10	0-10

B802.4 Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard, levelled and well drained. If necessary, the ground shall be covered with 50 mm plank.

B802.5 Water

B802.5.1 Only Potable water shall be used for construction work. Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. As a guide, the following concentrations represent the maximum permissible values:

- (a) To neutralise 200 ml sample of water, using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.
- (b) To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCl.

(c) The permissible limits for solids shall be as follows when tested in accordance with IS: 3025:

(d) Permissible Limits (max)

Organic	200 mg/lit
Inorganic	3000 mg/lit
Sulphates (SO ₄)	500 mg/lit
Chlorides (Cl)	500 mg/lit
Suspended matter	2000 mg/lit

* In case of building structures, the permissible limit of chlorides may be increased up to 1000 mg/litre.

B802.5.2 All samples of water (including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements stated herein.

B802.5.3 The pH value shall not be less than 6 and water shall meet all the requirements mentioned in Clause 5.4 of I S: 456-2000.

B803 CONCRETE ADMIXTURES

B803.1 General

B803.1.1 Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state.

B803.1.2 Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and full-fledged laboratory facilities for the manufacture and testing of concrete.

B803.1.3 The contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

- (a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.
- (b) The chemical names of the main ingredients in the admixtures.
- (c) The chloride content, if any, expressed as a percentage by the weight of the admixture.
- (d) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.
- (e) Whether or not the admixture leads to the entrapment of air when used as per the manufacturer's recommended dosage, and if so to what extent.
- (f) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.
- (g) Confirmation that there would be no risk of corrosion of the reinforcement or other embedment as a result of using the admixture.

B803.2 Physical and Chemical Requirements

- B803.2.1 Admixtures shall conform to the requirements of IS: 9103. In addition, the following conditions shall be satisfied:
- B803.2.2 "Plasticizers" and "Super-Plasticizers" shall meet the requirements indicated for "Water reducing Admixture".
- B803.2.3 Except where resistance to freezing and thawing and to disruptive action of de-icing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS: 1199 shall not be more than 2 percent higher than that of the corresponding control mix and in any case not more than 3 percent of the test mix.
- B803.2.4 The chloride content of the admixture shall not exceed 0.2 percent when tested in accordance with IS: 6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in Section B-1200 shall also be observed.
- B803.2.5 Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.
- B803.2.6 The tests that shall be performed along with permissible variations in the same are indicated below (as per IS 9103):
 - (a) Dry Material Content: to be within 3 percent and 5 percent of liquid and solid admixtures respectively of the value stated by the manufacturer.
 - (b) Ash content: to be within 1 percent of the value stated by the manufacturer.
 - (c) Relative Density (for liquid admixtures): to be within 2 percent of the value stated by the manufacturer.
- B803.2.7 All tests relating to the concrete admixtures shall be conducted periodically at an independent laboratory approved by the Employer and compared with the data given by the manufacturer.

B804 CONCRETE REQUIREMENTS

- B804.1 The following minimum requirements shall apply to reinforced concrete in land structures. Land structures comprise all reinforced concrete structures in buildings and on precast concrete piles or sub-base.

Land Structures	
Maximum Water/Cement Ratio by Weight	0.45
Minimum Cement Content	400 kg/m ³
Minimum 28 day Strength (Cube)	30 MPa
Maximum Drying Shrinkage (28 days)	500 macro strain
Slump	80mm*

* to be obtained by the use of an approved superplasticizer / high range water reducing agent as appropriate.

B805 GRADES OF CONCRETE

B805.1 General

B805.1.1 The grades of concrete shall be designated by the specified characteristic compressive strength as given in Table below (as per table 2 of IS 456.), where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Grade Designation	Specified Characteristic Compressive Strength of 150 mm cubes at 28 days, in N/mm ²
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40
M 45	45
M 55	55

B805.1.2 The specified characteristic compressive strength of structural concrete elements to be constructed under this Contract is as defined on the Drawings. Concrete for blinding or non-structural mass concrete fill applications shall be Grade M 20 unless noted otherwise on the Drawings.

B805.1.3 If the Contractor so elects, the Employer may permit the use of higher grade concrete than that specified on the drawing, in which event the higher grade concrete shall meet the specifications applicable thereto without additional compensation.

B805.1.4 Design Mix Concrete shall be used for all structural concrete works and shall be subject to the requirements for Design Mix Concrete set out in these specifications.

B805.1.5 Notwithstanding the above, where proposed by the Contractor, the Employer may at his sole discretion permit the use of Nominal Mix Concrete for Grade M 20 non-structural unreinforced mass concrete fill or blinding concrete which shall be subject to the requirements for Nominal Mix Concrete set out in these specifications.

B805.2 Size of Coarse Aggregate

B805.2.1 The size (maximum nominal) of coarse aggregates for concrete to be used in the works shall be 20mm except in confined or constrained applications where the maximum nominal size may be reduced to 10mm on a case by case basis subject to the agreement of the Employer.

B805.2.2 The proportions of the various individual sizes of aggregates shall be so adjusted that the grading produces densest mix.

B806 REQUIREMENTS FOR DESIGN MIX CONCRETE

B806.1 General

B806.1.1 The Contractor shall design concrete mixes for all Design Mix Concrete in accordance with the requirements of IS:456 and Mix Design Code (IS 10262 latest). The mix designs shall be based on the prevailing site and service conditions and shall be designed such that the requirements of these specifications are met.

B806.2 Target Mean Strength

B806.2.1 The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the 'current margin'.

- (a) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.65 times the standard deviation of samples test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.
- (b) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table below:

Concrete Grade	Current Margin (N/mm ²)	Target Mean Strength (N/mm ²)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58

B806.2.2 The initial current margin given in the Table above shall be used till sufficient data is available to determine the current margin as per sub-clause (a) above.

B806.3 Durability Requirements

B806.3.1 Durability requirements for Design Mix Concrete shall be based on the specified exposure class for the various concrete elements to be constructed under this Contract as given in Table below.

Exposure Class	Concrete Elements
Severe	Non-structural Mass Concrete Fill and Blinding Concrete
	Service Pits and Drainage Structures
	High Mast Light Tower Footings
	Concrete Kerbs and Edge Beams for Landside Pavement

Exposure Class	Concrete Elements
	/ Roadworks
Extreme	Bored Concrete Piles/ Precast Piles
	Precast Beams and slabs, kerb,
	In-situ Concrete Topping, Beams, Pile Caps, all marine concrete elements
	All other concrete elements unless deemed otherwise by the Employer

B806.3.2 The minimum cement content and water-cement ratios shall be maintained for the specified exposure classes as indicated in Table below.

Exposure Class	Min. cement content (kg/cum)	Maximum cement ratio	Water
Severe	400	0.45	
Extreme	420	0.40	

- (a) The minimum cement content is based on 20 mm aggregate (nominal max. size).
- (b) For underwater concreting, the cement content shall be increased by 10 percent.

B806.3.3 The cement content shall be low as possible but not less than the quantities specified above. In no case shall it exceed 540 kg/cum of concrete.

B806.3.4 The chloride content of the coarse and fine aggregate (determined in accordance with B.S. 812: Part 117), combined in the proportions intended for the particular concrete, shall not exceed 0.02% chloride ion by mass of combined aggregate.

B806.3.5 Measures to control the occurrence of alkali-aggregate reaction (AAR) in concrete for all concrete elements shall be submitted to the Employer for approval. In the absence of alternative proposals such control shall be achieved by limiting the reactive alkali content of the concrete. The properties of aggregates shall be such that the reactive alkali of any concrete used in the Contract expressed as the equivalent sodium oxide per cubic meter of concrete shall not exceed 3.0 kg.

B807 WORKABILITY REQUIREMENTS

B807.1 The mix shall have the consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency.

B807.2 The workability tests shall be carried out in accordance with IS 1199: Method of sampling & analysis of concrete.

B807.3 The Contractor shall nominate the target slump for the Design Mixes within the ranges nominated in Table below, or as directed by the Employer. The slump of concrete shall be checked as per IS 1199.

S. No.	Structure Type	Slump (mm)
1.	RCC structures with widely spaced reinforcements, e.g. solid columns, footings,	40–50
2.	RCC structures with fair degree of congestion of reinforcement; e.g. junction of quay beam and pile, walls with thickness greater than 300 mm, beam column junction etc.	50– 75
3.	RCC structures with highly congested reinforcements e.g. walls with thickness less than 300 mm	75 – 125
4.	Concreting through tremie e.g. cast-in-situ piling	100 – 200
5.	Pavement Quality Concrete	25 - 30

B808 SHRINKAGE REQUIREMENTS

B808.1 For all Design Mixes, the maximum drying shrinkage strain of concrete specimens prepared and tested in accordance with IS shall be as follows;

- (a) After 21 days drying period: 500 microstrain
- (b) After 56 days drying period: 700 microstrain

B809 ADMIXTURES

B809.1 Water-reducing admixtures (including plasticizers or super-plasticizers) may be used at the Contractor's option, subject to the approval of the Employer. Other types of admixtures shall be prohibited, unless specifically permitted by the Employer.

B809.2 Where two or more admixtures are proposed for incorporation into a concrete mix, their compatibility shall be certified by the manufacturers. No admixtures shall be used without written approval from the Employer.

B809.3 As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of his products only after obtaining complete knowledge of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the project.

B810 ADDITIONAL REQUIREMENTS

B810.1 Concrete shall meet with any other requirements as specified on the drawing or as directed by the Employer. Additional requirements shall also consist of the following overall limits of deleterious substances in concrete:

- (a) The total chloride content of all constituents of concrete as a percentage of mass of cement in mix shall be limited to 0.2 percent.
- (b) The total sulphuric anhydride (SO₃) content of all constituents of concrete as a percentage of mass of cement in the mix shall be limited to 4 percent.

B811 TRIAL MIXES

- B811.1 The Contractor shall give notice to enable the Employer to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor shall prepare trial mixes, using samples of approved materials typical of those he proposes to use in the works, for all grades to the Employer's satisfaction prior to commencement of concreting. The initial trial mixes shall generally be carried out and witnessed by the Employer or Employer's representative in an established laboratory approved by the Employer.
- B811.2 In exceptional cases, the Employer may at his sole discretion permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full-fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. In all cases complete testing of materials forming the constituents of proposed Design Mix shall have been carried out prior to making trial mixes.
- B811.3 Sampling and testing procedures shall be in accordance with these specifications.
- B811.4 During the finalization of Trial Mixes, the relationship between compaction factor and slump test shall be established for each grade of concrete as well as for various levels of workability.
- B811.5 When the site laboratory is utilized for preparing initial mix design, the concrete plant shall be able to produce the same mix proportion and means of transport of pre-mixed concrete shall be by transit mixers from the batching plant to the work location.
- B811.6 Test cubes shall be taken from trial mixes as follows. For each mix, set of six cubes shall be made from each of three consecutive batches. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Employer. The cubes shall be made, cured, stored, transported and tested in accordance with these specifications.

B812 SUBMISSION OF DESIGN MIXES

- B812.1 The Contractor shall submit the following information for the Employer's approval for each Design Mix:
- (a) Nature and source of each material and current test results not more than 12 months old demonstrating compliance with the materials requirements of these specifications;
 - (b) Quantities of each material per cubic metre of fully compacted concrete;
 - (c) Either of the following:
 - (i) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement(s) as specified.
 - (ii) Full details of tests on trial mixes.

B812.2 The Contractor shall submit the above documentation demonstrating that the proposed Design Mix conforms with the requirements of these specifications to the Employer for acceptance at least 14 days before the Design Mix is proposed to be used. The acceptance of this submission by the Employer shall constitute a HOLD POINT on the use of the Design Mix in the works.

B813 VARIATION TO DESIGN MIXES

B813.1 Any change in the source of material or in the mix proportions shall be subject to the Employer's prior approval.

- (a) Adjustment to Mix Proportions
 - (i) Adjustments to mix proportions arrived at in the trial mixes shall be made subject to the Employer's approval, in order to minimise the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.
- (b) Change of Current Margin
 - (i) When required by the Employer, the Contractor shall recalculate the current margin as deemed appropriate. The recalculated value shall be adopted as directed by the Employer, and it shall become the current margin for concrete produced subsequently.
- (c) Additional Trial Mixes
 - (i) During production, the Contractor shall carry out trial mixes and tests, if required by the Employer, before substantial changes are made in the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with this clause.

B814 REQUIREMENTS FOR NOMINAL MIX CONCRETE

B814.1 Requirements for nominal mix concrete unless otherwise specified shall be as detailed in Table below.

Concrete Grade	Total Quantity of dry aggregate by mass per 50 kg of cement to be taken as the sum of individual masses of fine and coarse aggregates (kg)	Proportion of fine to Coarse aggregate (by mass)
M 20	250	Generally, 1:2, subject to upper limit 1:1.5 and lower limit of 1:1.25

B814.2 Submission of Nominal Mix(s)

B814.2.1 The Contractor shall submit the following information for the Employer's approval for each Design Mix:

- (a) Nature and source of each material and current test results not more than 12 months old demonstrating compliance with the materials requirements of these specifications;

- (b) Statement giving the proposed mix proportions for nominal mix concrete.
- (c) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement(s) as specified.

B814.2.2 The Contractor shall submit the above documentation demonstrating that the proposed Nominal Mix conforms with the requirements of these specifications to the Employer for acceptance at least 14 days before the Nominal Mix is proposed to be used. The acceptance of this submission by the Employer shall constitute a HOLD POINT on the use of the Nominal Mix in the works.

B815 BATCHING AND MIXING OF CONCRETE

B815.1 General

B815.1.1 Details of equipment for the production, batching and mixing of concrete for use in the works shall be as proposed by the Contractor in his CWMS for the concrete works and shall be subject to the acceptance of the Employer and the requirements of these specifications.

B815.1.2 Production of concrete for all Works shall be carried out using concrete batching and mixing plant fully automatic with minimum capacity of 30 cum per hour.

B815.1.3 All materials, stockpile bins, silos and storage areas shall be clearly marked such that operators can read the labels from their normal working locations. Any cross contamination from one storage area to the other shall be treated as a non-conformance.

B815.1.4 All measuring devices of the equipment shall be maintained in a clean and serviceable condition. Its accuracy shall be checked over the range in use, when set up at each site and thereafter periodically as directed by the Employer.

B815.1.5 The accuracy of the measuring devices shall fall within the following limits:

- (a) Measurement of Cement +3 percent of the quantity of cement in each batch
- (b) Measurement of Water +3 percent of the quantity of water in each batch
- (c) Measurement of Aggregate +3 percent of the quantity of aggregate in each batch
- (d) Measurement of Admixture +5 percent of the quantity of admixture in each batch

- B815.1.6 Concrete shall be mixed either in a concrete mixer or in a batching and mixing plant, as per these specifications. Hand mixing shall not be permitted. The batching plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Employer. The batching capacity, method of loading, mixing time and speed of operation shall be measured by the Contractor and noted in the CWMS for the concrete works.
- B815.1.7 Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained. The mixing time from the time of adding water shall be in accordance with IS 1791-1985, In no case shall mixing be done for less than 2 minutes or at least 40 revolutions.
- B815.1.8 Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Mixing plant shall be thoroughly cleaned before changing from one type of concrete to another.
- B815.1.9 The Contractor shall keep full and detailed batch records and materials test results for all concrete produced. Copies of the test results shall be submitted to the Employer progressively throughout the works and a full set shall be submitted upon completion of the Works.

B816 TRANSPORTATION AND DELIVERY OF CONCRETE

B816.1 General

- B816.1.1 Concrete shall be transported to the point of discharge by truck mounted drum mixers. On completion of mixing the concrete shall be continuously agitated until it is fully discharged.
- B816.1.2 The method of transporting and placing concrete shall be included in the Contractors CWMS for the concrete works and approved by the Employer. Concrete shall be transported and placed as near as practicable to its final position, so that no contamination, segregation or loss of its constituent materials takes place.
- B816.1.3 When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. Maximum fall height shall be limited to 1.2 m. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.
- B816.1.4 The time from addition of the cement to the aggregates until concrete placement and compaction shall not exceed 60 minutes. Irrespective, concrete shall not be placed in the works if its consistency is outside the specified tolerances. Concrete when deposited shall have a temperature of not less than 5 degrees Celsius, and not more than 40 degrees Celsius. Under no circumstances shall water be added to a batched load of concrete. In all such matters, the Employer's decision shall be final.

B816.2 Slump/Consistency

B816.2.1 The slump of the concrete shall be tested in accordance with the requirements of IS 1199. If the measured slump is not within the specified limits, one repeat test shall be made immediately from another portion of the same sample. If the value obtained from the repeat test falls within the specified limits, the concrete represented by the sample shall be deemed to comply with the specified value, otherwise the load shall be rejected.

B817 PLACEMENT, COMPACTION AND FINISHING OF CONCRETE

B817.1 General

B817.1.1 All formwork and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete.

B817.1.2 No concrete shall be placed in any part of the structure until the approval of the Employer has been obtained.

B817.1.3 If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Employer. Concreting then shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.

B817.1.4 Except where otherwise agreed to by the Employer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not exceeding 300 mm in all other cases. Approved mechanical vibrators of adequate power and having a frequency of not less than 6000 impulses per minute shall be used for compacting concrete.

B817.1.5 Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimise the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc., shall be avoided. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and a half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns.

B817.1.6 Mechanical vibrators used are to comply with IS: 3558, IS:7246,

B817.2 **Finishing**

B817.2.1 Immediately after the removal of forms, all fins caused by form joints, all cavities produced by the removal of form ties other holes and depressions, honeycomb spots, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used subject to the approval of the Employer.

B817.2.2 All construction and expansion joints in the completed work shall be carefully tooled and cleared from any mortar and concrete and filled with appropriate joint filler material.

B817.2.3 Immediately on removal of forms, the concrete work shall be examined by the Employer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance shall be rejected. Surface defect of a minor nature may be accepted. On acceptance of such work by the Employer, the same shall be rectified as directed by the Employer.

B817.3 **Construction Joints**

B817.3.1 Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings, except with express approval of the Employer. The joint shall be provided as shown in the drawings.

B817.3.2 Construction joint surfaces shall be formed by the use of surface retarders painted onto the surface of the construction joint form or stop end and subsequent high pressure water blasting to achieve a pronounced profile with a surface roughness of not less than 3mm. All loose aggregate particles and laitance shall be removed.

B817.3.3 Keyways shall be formed in all construction joints to provide resistance against shear across at least 40% of the section. Key ways shall be accurately formed to approved dimensions with formwork which will not be displaced during concreting. Water stops shall be provided at construction joints in water retaining structures and water tight structures, together with joint seals on the side retaining the water.

B817.3.4 Immediately before placing fresh concrete against faces of previously placed and hardened concrete, the surface of construction joints shall be thoroughly cleaned and wetted with clean water and approved (Employer) bonding agents has to be applied as per specification such that the surface of the construction joint is moist when fresh concrete is placed against it. Horizontal joints in structures subject to vibration shall be covered with a thick layer of sand/cement mortar immediately prior to placing the concrete on them. The concrete shall be thoroughly vibrated against the joint.

B817.4 For Concrete Directly on Earth Foundation

B817.4.1 Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Employer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Employer without any extra cost to the Employer. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

B817.4.2 The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Employer without any extra cost to the Employer.

B817.5 Anti-Termite treatment:

B817.5.1 The soil shall be treated using chemical emulsion by drilling 12 mm diameter holes upto 300mm depth at 150 mm center to center: With Imidacloprid 30.5% SC at 2.1 ml per liter of water as per IS 16131. The above work shall be carried out by an agency having sufficient experience and should ensure a service warranty of 10 years. Only skilled and experienced persons shall be employed for this purpose. The contractor need approval for the agency from Employer. The treated soil shall be immediately covered with polyethylene sheet of 1000 microns and concrete should be poured within 24 hours after anti termite treatment.

B817.6 Cold Joint:

B817.6.1 An advancing face of a concrete pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold joints. If, however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it:

- (a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete along with the old concrete shall be vibrated systematically and thoroughly.
- (b) In case the concrete has hardened a bit more than (a), but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. Then a rich mortar layer of 12 mm thickness, shall be placed on the cold joint and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly, penetrating deep into the layer of concrete.

B817.6.2 In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete shall be done as per the recommendation by Employer

B818 CONCRETING UNDER WATER

B818.1 General

B818.1.1 When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used shall be got approved from the Employer before any work is started. Concrete shall contain 10 percent more cement than that required for the same mix placed in the dry.

B818.1.2 Concrete shall not be placed in water having a temperature below 5 degrees Celsius. The temperature of the concrete, when deposited, shall not be less than 16 degrees Celsius, nor more than 40 degrees Celsius.

B818.1.3 Cofferdams or forms shall be sufficiently tight to ensure still water conditions, if practicable, and in any case to reduce the flow of water to less than 3 meters per minute through the space into which concrete is to be deposited. Cofferdams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter. To minimise the formation of laitance, great care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

B818.1.4 All under water concreting shall be carried out by tremie method only, using tremie of appropriate diameter. The number and spacing of the tremies should be worked out to ensure proper concreting. The tremie concreting when started should continue without interruption for the full height of the member being concreted. The concrete production and placement equipment should be sufficient to enable the underwater concrete to be completed uninterrupted within the stipulated time. Necessary stand-by equipment should be available for emergency situation.

B818.1.5 The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength for the job shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise slowly the tremie in order to allow a uniform flow of concrete, but it shall not be emptied so that water is not allowed to enter above the concrete in the pipe. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the concrete. This will cause the concrete to build up from instead of flowing out over the surface and thus avoid formation of layers of laitance.

B819 ADVERSE WEATHER CONDITIONS

B819.1 Concreting in Inclement Weather

B819.1.1 In the event of rainstorm or any other severe conditions arising, concreting shall be stopped and appropriate temporary stop ends, vee grooves, etc. placed as may be necessary. During wet weather, the concrete shall be adequately protected as soon as put into position.

B819.1.2 The Contractor shall always have in readiness approved framed sheeting, tarpaulin, etc. for the protection of newly placed concrete during inclement weather. Should any concrete be damaged due to rainstorms or other weather conditions, the Employer may order the cutting out and replacement of the damaged concrete, all at the expense of the Contractor.

B820 PROTECTION AND CURING

B820.1 General

B820.1.1 Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor.

B820.1.2 Curing and protection of concrete shall start immediately after compaction of the concrete to protect it from:

- (i) Premature drying out particularly by solar radiation and wind
- (ii) High internal thermal gradients
- (iii) Leaching out by rain and flowing water
- (iv) Rapid cooling during the first few days after placing
- (v) Low temperature or frost
- (vi) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement

- B820.1.3 Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Employer.
- B820.2 **Water Curing**
- B820.2.1 Water for curing shall be as specified for use in Structural Concrete previously in this section.
- B820.2.2 Sea water shall not be used for curing. Sea water shall not come into contact with concrete members unless it has attained adequate strength.
- B820.2.3 Sprinkling of water shall be done after 2 hours of initial setting time and exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacks, canvas, Hessian cloth or similar materials which shall be covered with polyethylene sheet of minimum thickness of 250 microns and shall be kept constantly wet for a period of not less than 14 days from the date of placing of concrete.
- B820.3 **Steam Curing**
- B820.3.1 Where steam curing is adopted, it shall be ensured that it is done in a suitable enclosure to contain the live steam in order to minimise moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.
- B820.3.2 Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.
- B820.3.3 The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete and the ambient air temperature shall increase at a rate not exceeding 5 degrees Celsius per hour until a maximum temperature of 60 degrees Celsius to 70 degrees Celsius is reached. The maximum temperature shall be maintained until the concrete has reached the desired strength.
- B820.3.4 When steam curing is discontinued, the ambient air temperature shall not drop at a rate exceeding 5 degrees Celsius per hour until a temperature of about 10 degrees Celsius above the temperature of the air to which the concrete will be exposed, has been reached.
- B820.3.5 The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

B820.4 Curing Compounds

B820.4.1 Curing compounds shall only be permitted in special circumstances and will require specific approval of the Employer. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist, cured and no curing compound will be permitted in locations where concrete surface are required to be bonded together.

B820.4.2 Curing compounds shall be continuously agitated during use. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately after acceptance of concrete finish. If the surface is dry, the concrete shall be saturated with water and curing compound applied as soon as the surface film of water disappears. The second application shall be made after the first application has set. Placement in more than two coats may be required to prevent streaking.

B821 INSTALLATION OF PRECAST CONCRETE UNITS

B821.1 General

B821.1.1 Contact surfaces between in-situ concrete and precast concrete units shall be prepared as stated in the Contract. Dimensional tolerances shall be checked before the precast concrete units are lifted into position. All lifting, handling and storage procedures shall be approved by the Employer before their implementation.

B821.1.2 Temporary supports and connections shall be provided as soon as practicable during installation of precast concrete units.

B821.1.3 Final structural connections shall be completed as soon as practicable after the precast concrete units have been installed.

B821.1.4 Levelling devices which have no load bearing function in the finished structure shall be slackened, released or removed after the precast concrete units have been installed.

B821.1.5 The Contractor shall maintain records of the identification and serial number of each unit at each location where precast units are placed in the permanent Works. The records shall be submitted to the Employer within 7 days of the last concrete poured on each individual structure or part of structure as agreed in advance with the Employer.

B821.1.6 Any pre-cast concrete unit, which is damaged or has any perceptible faults, will be liable to be rejected by Employer.

B821.1.7 Concrete beams shall not normally be placed in position less than 28 days after casting of the sub-structures. Should an earlier placing time be required the Contractor shall provide design calculations to show the sub-structure is of adequate strength to support the beams.

B822 TOLERANCES

- B822.1 Tolerances for dimensions/shape of various components shall be as indicated in these specifications or as directed by the Employer.
- B822.2 Unless otherwise specified the tolerance in position for in-situ concrete in the finished Work shall be:-
- (a) Variation of level or lateral position of any point from its level or lateral position indicated on or computed from the drawings to be 12 mm
 - (b) not withstanding (a) above variation from the vertical in any 3 m 6 mm in any 12 m 18 mm
 - (c) variation in slab and wall thickness + 6 mm, - 2 mm
 - (d) maximum rate of deviation from mean level of any surface or any beam soffit in any 3m to be 3 mm
 - (e) maximum deviation from nominal cross section dimensions of columns, beams, walls, floors, roof slabs, and other structures including dimensions of openings in all in-situ concrete (but excluding stressed members)
 - (i) dimension less than 150mm: + 10 mm, - 2 mm
 - (ii) dimension of 150mm or greater: + 12 mm, - 3 mm
 - (f) maximum deviation from any nominal cross section for stressed members
 - (i) dimension less than 75mm + 2mm, - 0mm
 - (ii) dimension of 75mm to 450mm + 3mm- 0mm
 - (iii) dimension over 450mm + 5mm, - 0mm
 - (iv) maximum rate of deviation in any 3m 3mm
 - (g) maximum differential in surface across deck joint to be 3 mm
- B822.3 Unless otherwise specified the tolerances for precast concrete construction in the finished work shall be as given in BS 8110 Part I Clause 6.11 with the following exceptions:-
- (a) for straightness both in plan and elevation the tolerance shall be half that specified;
 - (b) for the length of beams the tolerance shall be + 10 mm.
- B822.4 The allowable tolerances noted above shall never be allowed to cause an abrupt or visible change in the face of the finished concrete.
- B822.5 The position of cast in items in in-situ concrete shall be controlled, including the use of templates where appropriate, to achieve a tolerance in position (variation in level or lateral position) from the position indicated or computed of ± 3 mm.
- B822.6 Discrepancies in dimensions of the concrete construction works shall be rectified by methods approved by the Employer. If the said concrete construction works cannot be rectified to the satisfaction of the Employer, the concrete construction works shall be removed and reconstructed.

B823 TESTS AND STANDARDS OF ACCEPTANCE

B823.1 General

B823.1.1 Concrete shall conform to the surface finish and tolerance as prescribed in these specifications for respective components.

B823.1.2 Random sampling and lot by lot of acceptance inspection shall be made for the 28 days cube strength of concrete.

B823.1.3 Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following:

- (a) No individual lot shall be more than 30 cum in volume;
- (b) At least one cube forming an item of the sampling representing the lot shall be taken from concrete of the same grade and mix proportions cast on any day;
- (c) Different grades of mixes of concrete shall be divided into separate lots;
- (d) Concrete of a lot shall be used in the same identifiable component of the structure.

B823.2 Sampling and Testing

B823.2.1 Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure laid down in IS: 1199.

B823.2.2 A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, that is the sampling should be spread over the entire period of concreting and cover all mixing units.

B823.2.3 150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS: 516. The 28-day test strength result for each cube shall form an item of the sample. In all cases 28-day compressive strength specified in Table-2 of IS: 456-2000 shall alone be the criterion for acceptance or rejection of the concrete.

B823.3 Test Specimen and Sample Strength

B823.3.1 Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

B823.3.2 The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than + 15 percent of the average.

B823.4 Frequency

B823.4.1 The minimum frequency of sampling of concrete of each grade shall be in accordance with Table below (clause 15.2 of IS: 456-2000).

Quality of concrete in work, m ³	No. of samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 – and above	4 plus one additional sample for each additional 50 m ³ or part thereof

B823.4.2 At least one sample shall be taken from each shift of work.

B823.5 Acceptance Criteria

B823.6 Compressive Strength

B823.6.1 When both the following conditions are met, the concrete complies with the specified compressive strength:

B823.6.2 The mean strength determined from any group of four consecutive samples should exceed the specified characteristic compressive strength.

B823.6.3 Strength of any sample is not less than the specified characteristic compressive strength.

B823.6.4 The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

B823.7 Chloride and Sulphate Content

B823.7.1 The total chloride and sulphuric anhydride (SO₃) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this section of the specifications.

B823.8 Density of Fresh Concrete

B823.8.1 Where minimum density of fresh concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

B823.9 Density of Hardened Concrete

B823.9.1 Where minimum density of hardened concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

B823.10 Permeability Test

B823.10.1 The concrete should pass the following test if it is properly compacted and is not considered permeable.

- (i) Prepare a cylindrical test specimen 150 mm dia and 160 mm high
- (ii) After 28 days of curing, the test specimen is fitted in a machine such that the specimen can be placed in water under pressure up to 7 bars.
- (iii) At first a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for next 24 hours.
- (iv) After the passage of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.
- (v) The water penetration in the broken core is to be measured with a scale and the depth of penetration assessed in mm (max. permissible limit 25 mm).

B823.10.2 If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Employer. The Employer may accept the concrete as sub-standard work. Any additional work required by the Employer for such acceptance shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable after investigation, the Contractor shall remove the rejected concrete forthwith.

B900 STEEL REINFORCEMENT

B901 DESCRIPTION

B901.1 General

B901.1.1 This work shall consist of furnishing and placing uncoated mild steel or high strength deformed reinforcement bars of the shape and dimensions conforming to these Specifications or as approved by the Employer.

B901.1.2 Reinforcements should be Corrosion Resistant Steel (CRS) high strength deformed TMT bars. Reinforcements shall be uncoated unless specified otherwise or directed by the Employer.

B902 MATERIALS

B902.1 Reinforcement

B902.1.1 For Reinforced Cement Concrete (RCC) works, the reinforcement shall consist of the following grades of reinforcing bars (as designated on the Drawings).

Grade Designation	Bar Type conforming to governing IS Specification	Characteristic Strength fy (MPa)	Elastic Modulus (GPa)
Fe 500 D	IS: 1786 CRS TMT High Yield Strength Deformed Bars (HYSD)	500	200

B902.1.2 Other grades of bars conforming to IS: 1786 shall not be permitted.

B902.1.3 All steel shall be procured from original producers; no re-rolled steel shall be incorporated in the work.

B902.1.4 Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

B902.1.5 The reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms, skids, or other supports with well-drained surface, and shall be protected from mechanical injury and from deterioration by exposure.

B902.1.6 The unit weight and cross sectional area of the reinforcement bar shall be as per the as per IS 1786 Clause 6.2, Table 2

B903 WORKMANSHIP

B903.1 Protection of Reinforcement

B903.1.1 Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sand blasting, mechanical wire brushing, etc., as directed by the Employer. Reinforcements shall be stored on block, racks or platforms and above the ground in a clean and dry

condition and shall be suitably marked to facilitate inspection and identification.

B903.1.2 Portions of uncoated reinforcing steel and dowels projecting from concrete shall be protected within one week after initial placing of concrete with a brush coat of neat cement mixed with water. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete.

B903.2 Bending of Reinforcement

B903.2.1 Bar bending schedule shall be furnished by the Contractor and approved by the Employer before start of work. For approval, Bar Bending schedule shall be submitted to the Employer at least two weeks before the bars are to be bent.

B903.2.2 Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules.

B903.2.3 Bars shall be bent cold to the specified shape and dimensions or as directed by the Employer using a proper bar bender, operated by hand or power to obtain the correct radii of bends and shape.

B903.2.4 Bars shall not be bent or straightened in a manner that will damage the parent material or the coating.

B903.2.5 Bars bent during transport or handling shall be straightened before being used on work and shall not be heated to facilitate straightening.

B903.3 Placing of Reinforcement

B903.3.1 The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. Prolonged time gap between assembling of reinforcements and casting of concrete, which may result in rust formation on the surface, shall not be permitted.

B903.3.2 Reinforcement bars shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to IS: 280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1mm.

B903.3.3 Bars shall be kept in position usually by the following methods:

- (a) In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover shall be placed between the bars and formwork subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Employer, provided they have the same strength and specifications as those of the member.

- (b) In case of dowels for columns and walls, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concreting has progressed up to a level just below their location.
- (c) Layers of reinforcements shall be separated by spacer bars at approximately one metre intervals. The minimum diameter of spacer bars shall be 12 mm or equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be allowed to sag between supports.
- (d) Necessary stays, blocks, metal chairs, spacers, metal hangers, supporting wires etc. or other subsidiary reinforcement shall be provided to fix the reinforcements firmly in its correct position.
- (e) Use of pebbles, broken stone, metal pipe, brick, mortar or wooden blocks etc., as devices for positioning reinforcement shall not be permitted.
- (f) Sufficient to say that reinforcement placement should be done as per IS 2502: code of practice for bending and fixing of bars for concrete reinforcement (latest revision)

B903.3.4 Placing and fixing of reinforcement shall be inspected and approved by the Employer before concrete is deposited. When indicated diameter of reinforcement bar is not available, the Contractor shall use other diameter of reinforcement bars on written approval of the Employer.

B904 BAR SPLICES

B904.1 Lapping

B904.1.1 All reinforcement shall be furnished in full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing, will be permitted without approval of the Employer. The lengths of the splice shall be as indicated on drawing or as approved by the Employer. Overlapping bars shall be bound with annealed steel binding wire, not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface. Lapped splices shall be staggered or located at points, along the span where stresses are low. Lapping of bars shall be done in accordance with the relevant requirements specified in IS: 456 Code of Practice for Plain and Reinforced Concrete (Latest Revision). Laps shall be staggered.

B904.2 Welding

B904.2.1 Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Employer. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

B904.2.2 The method of welding shall conform to IS: 9417 and to any supplemental specifications to the satisfaction of the Employer.

- B904.2.3 Welding may be carried out by metal arc welding process. Precautions on overheating, choice of electrode, selection of correct current in arc welding etc., should be strictly observed. Oxy-acetylene welding shall not be used.
- B904.2.4 When appropriate lap lengths are not available, all bars shall be butt welded conforming to IS: 9417 except for smaller diameter bars (diameter of less than 20 mm) which may be lap welded. Single-V or Double-V butt joints may generally be used. For vertical bars single bevel or double bevel joints may be used.
- B904.2.5 Welded joints shall be located well away from bends and not less than twice the bar diameter away from a bend.
- B904.2.6 Generally, shop welding in controlled conditions is to be preferred, where feasible. Site welding where necessary shall, however, be permitted when the facilities, equipment, process, consumables, operators, welding procedure are adequate to produce and maintain uniform quality at par with that attainable in shop welding to the satisfaction of the Employer.
- B904.2.7 Joint welding procedures which are to be employed shall invariably be established by a procedure specification. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS: 9417. Visual Inspection of welds and quality control tests shall conform to IS: 9417 and destructive or non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional check inspection shall not be accepted.
- B904.2.8 M.S. electrodes used for welding shall conform to IS: 814.
- B904.3 **Mechanical Coupling of Bars**
- B904.3.1 Bars may be jointed with approved patented mechanical devices conforming to IS: 16172 and as indicated on the drawing or as approved by the Employer e.g. by special grade steel sleeves swaged on to bars in end to end contact or by screwed couplers. In case such devices are permitted by the Employer, they shall develop at least 125 percent of the characteristic strength of the reinforcement bar. The coupler shall be qualified as per ASME, Section III, and Div.2.

B905 TESTING AND ACCEPTANCE

B905.1 General

- B905.1.1 The material shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, will be got carried out by the Contractor at his own cost.
- B905.1.2 The fabrication, furnishing and placing of reinforcement shall be in accordance with these specifications and shall be checked and accepted by the Employer.

B1000 STRUCTURAL METALWORK

B1001 DESCRIPTION

- B1001.1 This work shall include furnishing, fabricating, transporting, erecting and painting structural steel, cast steel, steel forgings, cast iron, aluminium and other incidental metal construction of the kind, size and quantity in conformity with the drawings and these specifications or as desired by the Employer.
- B1001.2 Items covered include, but are not limited to, building roof frames and trusses, pipe and cable supports, cope point and escape and materials hatch frames and covers, deck ventilation grates, pit covers and grates, trench grates, edge angles to rail and crane cable recesses, platforms, walkways, floor grating, ladders, stairs and hand rails, holding down bolts, U bolts for fenders, cast in inserts, bolts, nuts and washers and any other miscellaneous plates and sections.

B1002 GENERAL

- B1002.1 General requirements relating to the supply of material shall conform to the specifications of IS: 1387, for the purpose of which the supplier shall be the Contractor and the purchaser shall be the Employer.
- B1002.2 Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges and other defects. It shall have a smooth and uniform finish and shall be straightened in the mill before shipment. They shall also be free from loose mill scale, rust, pits or other defects affecting its strength and durability.
- B1002.3 The acceptance of any material on inspection at the mill i.e. rolling, mills, foundry or fabricating plant where material for the work is manufactured, shall not be a bar to its subsequent rejection, if found defective.
- B1002.4 Unless specified otherwise, bolted connection of structural joints using high tensile friction grip bolts shall comply with requirements of IS: 4000.
- B1002.5 The technical requirements of this Specification are the absolute minimum acceptable. Where not specifically referenced herein, materials and workmanship shall comply with the latest edition and amendments of the applicable Indian Standard.

B1003 SHOP DRAWINGS

- B1003.1 Prior to fabrication of any steelwork, the Contractor shall prepare fully detailed and dimensioned shop drawings in accordance with these specifications.
- B1003.2 The drawings shall show full and complete information regarding the size, location and type of welds and the sequence that shall be employed to minimise construction stresses and distortion. The approved welding procedures shall also be fully detailed on the shop drawings and strictly adhered to in production.

B1003.3 The Contractor shall submit the shop drawings to the Employer for acceptance 14 days before the intended commencement of fabrication of the items to which the shop drawings refer. The Employer will take maximum 7 days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

B1003.4 The resolution of such comments on the shop drawings to the satisfaction of the Employer and the Employer's subsequent approval of the shop drawings shall constitute a HOLD POINT on the commencement of the steel fabrication works to which the shop drawings refer.

B1004 MATERIALS

B1004.1 General

B1004.1.1 Unless otherwise permitted herein, all structural steel shall before fabrication comply with the requirements of the following Indian Standards:

- IS: 808: Specifications for Rolled Steel Beam, Channel and Angle Sections
- IS: 1161: Steel Tubes for Structural Purposes Specification
- IS: 1239: Mild Steel Tubes
- IS: 1730: Dimension for Steel Plate, sheet and strip for structural and general Engineering purposes
- IS: 1731: Dimension for Steel flats for structural and general Engineering purposes
- IS: 1732: Dimension for round and square steel bars for structural and general Engineering purposes
- IS: 1852: Rolling and cutting tolerances for hot rolled steel products
- IS: 2062: Steel for General Structural Purposes Specification
- IS: 4923: Hollow Steel sections for structural use
- IS: 11587: Structural weather resistant steel

B1004.1.2 The use of structural steel not covered by the above standards may be permitted only with the specific approval of the Employer.

B1004.1.3 Plain washers shall be of steel. Tapered or other specially shaped washers shall be of steel or malleable cast iron.

Fasteners: Bolts, nuts, and washers shall comply with the following or relevant IS Standards as appropriate:

- IS: 1363 Hexagon head bolts, screw and nuts product grade C
- IS: 1367 Technical supply conditions for threaded steel fastener (Part 1 to 18)
- IS: 2016 Specification for Plain Washers
- IS: 3640 Hexagon fit bolts
- IS: 3757 High tensile friction grip bolts
- IS: 5369 Plain washers and lock washers – general requirements
- IS: 5370 Plain washers with outside dia = 3 x inside dia
- IS: 5372 Taper washers for channel (ISMC)
- IS: 5374 Taper Washers for I beams (ISMB)

- IS: 5624 Foundation bolts
- IS: 6610 Heavy washers for steel structures
- IS: 6623 High strength structural nuts
- IS: 6639 Hexagon bolts for steel structure
- IS: 6649 Hardened and tempered washers for high strength structural bolts and nuts
- IS: 7002 Prevailing torque type steel hexagon lock nuts

B1004.2 Welding consumables

Welding consumables shall comply with the following Indian Standards as appropriate:

- IS: 814 Covered Electrodes for Metal Arc Welding of structural steel for (Part 1) welding other than sheet
- IS: 814 For welding sheets (Part 2)
- IS: 816 Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel.
- IS: 822 Code of Procedures for Inspection of Welds
- IS: 1278 Filler rods and wires for gas welding
- IS: 1395 Low and medium alloy Steel covered electrodes for manual Metal Arc Welding
- IS: 3613 Acceptance Tests for wire flux combinations for sub-merged arc welding of structural steel
- IS: 7280 Bare wire electrodes for gas shield arc welding of structural steel
- IS: 6419 Welding rods and bare electrodes for gas shielded arc welding of structural steel
- IS: 6560 Molybdenum and chromium-molybdenum low alloy steel welding rods and bare electrodes for gas shielded arc welding

B1004.2.1 In aggressive environment, corrosion resistant steel can be used. These are low-alloyed steels containing a total of 1 percent – 2 percent alloys, in particular, copper, chromium, nickel and phosphorous.

B1004.2.2 Following documents are also referred to in this specification.

- IS: 210: Grey Iron Castings - Specification
- IS: 736: Wrought Aluminium and Aluminium Alloy Plate for General Engineering Purposes
- IS: 1865: Iron Castings and Spheroidal or Nodular Graphite Specification
- IS: 808: Specifications for Rolled Steel Beam, Channel and Angle Sections
- IS: 2629: Recommended Practice for Hot Dip Galvanising of Iron and Steel
- IS: 4759: Hot Dip Zinc Coating on Structural Steel and Other Allied Products – Specification
- IS: 4912: Safety Requirements for Floor and Wall Openings Railing and Toe Boards

- IS: 5206: Specifications for Covered Electrodes for Manual Arc Welding for Stainless Steel and Other Similar High Alloy Steels
 IS: 6911: Stainless Steel Plate, Sheet and Strip – Specification
 IS: 7273: Method of Testing Fusion Welded Joints in Aluminium and Aluminium Alloys
 IS: 8147: Code of Practice for use of Aluminium Alloys in Structures
 IS: 9595: Metal Arc Welding of Carbon and Carbon Manganese Steels- Recommendations

Steel	
Hot rolled sections to IS 808 and IS 2062	Grade 250 or Grade 300
Hot rolled plates, sheets, strips and flats to IS 1730 and IS 2062	Grade 250 or Grade 3050
Hollow sections: <ul style="list-style-type: none"> • Tubes to IS 1161 • Square and rectangular hollow sections to IS 4923 	Grade 240 or Grade 310
Stainless steel to IS 6911	Grade 316
Aluminium	
Aluminum plate to IS 736	Marine Grade Alloy 5083-H1 16
Cast Iron	
Spheroidal or nodular graphite cast iron to IS 1865 Grey cast iron to IS 210	Grade SG 600 or Grade FG 220

B1005 TECHNICAL REQUIREMENTS

B1005.1 Materials

B1005.1.1 Type and Grade of Steel, Aluminium and Cast Iron Unless otherwise shown on the Drawings, all steel, aluminium and cast iron shall comply with other types and grades of steel, aluminium or cast iron shall not be used without the Employer's approval. Stainless steel plates and sections shall have a minimum 0.2% proof stress of 300MPa unless noted otherwise on the Drawings.

B1005.1.2 All materials shall be new and surface defects shall be removed using the method specified in the appropriate standard

B1006 STEEL FLOOR GRATING

B1006.1 All floor grating with or without chequered plate top cover, unless noted otherwise, shall be as shown on the Drawings. All floor grating shall be plain pattern. Grating shall be banded at openings in platforms, around removable panels, at ends and at locations called for on the Drawings. All grating units shall be hot-dipped galvanized.

B1007 SUPPLY AND SUBSTITUTION

B1007.1 Substitution of structural sections, grade or length shall not be made without the written permission of the Employer.

B1007.2 Members shall be made of single lengths unless otherwise permitted by the Employer in writing.

B1008 TESTING

B1008.1 The Contractor shall obtain from the respective manufacturers for all steel and aluminium, test certificates stating that these materials have been tested and found to comply with the requirements of the relevant standards and shall forward these to the Employer. The Contractor should arrange for In-situ tests of all stainless steel material to ascertain the quality of material i.e. stainless steel fixtures/accessories as per manufacturer's standard / BIS / ASTM standard, to the satisfaction of Employer.

B1009 DIMENSIONS

B1009.1 The Contractor shall verify all dimensions and be responsible for their accuracy.

B1009.2 Any discrepancies shall be referred to the Employer immediately and an instruction obtained before work on the affected part is commenced.

B1010 DESIGN AND DRAWINGS

B1010.1 The Contractor shall prepare Detailed design, workshop fabrication drawings of steelwork, aluminium and cast iron and submit three copies of each for the Employer's review of general compliance with the design, at least 21 days prior to fabrication. The softcopies of drawings shall also be provided in CD-ROM. Fabrication shall not commence until the shop drawings have been reviewed, when an appropriately stamped copy will be returned to the Contractor.

B1010.2 The drawings shall show, in standard Engineering drawing manner, clear and complete details of each assembly, component and connection in the work, together with all information relative to their fabrication, surface treatment and erection, including the following:

- (a) Identification/markings
- (b) Steel, aluminium and cast iron type and grade
- (c) Dimensions of items
- (d) Required camber, where applicable
- (e) Fabrication methods including, where applicable, hot and cold forming and post weld heat treatment
- (f) Location, type and size of welds or bolts

- (g) Weld categories and bolting categories
- (h) Orientation of members
- (i) Location of temporary connections
- (j) Surface preparation methods and Protective coating system
- (k) Procedures necessary for shop and site assembly
- (l) Lifting and support points for handling and transport
- (m) Temporary bracing, if required for handling and transport
- (n) Required fixings for adjoining elements
- (o) Procedures for erection including temporary bracing
- (p) Corrosion protection requirements such as sealed hollow sections, shedder plates and the like

B1010.3 The Contractor shall verify on site the pocket location for holding down bolts for structures before fabrication of affected metalwork.

B1010.4 The Employer's review shall not abrogate the Contractor's responsibility for the accuracy of the design, fabrication drawings, welding procedures and erection procedures.

B1011 INSPECTION

B1011.1 All material and work is liable to be subject to inspection by the Employer at any time. The defective / rejected materials and should be immediately remove from site and additional charges (loading, unloading, transportation etc.) shall be borne by the contractor. The Contractor shall provide the necessary safe access and facilities at the fabrication shop and erection site.

B1011.2 The inspection and acceptance of the fabricated structure by Employer shall constitute a HOLD POINT prior to the erection of structure. Erection or installation of steel structure shall constitute a WITNESS POINT for the Employer or his delegated representative.

B1012 WORKMANSHIP

B1012.1 Workmanship of structural steel shall be in accordance with IS 800.

B1012.2 Where portions of the work are exposed to view, attention shall be given to the finish. Shearing, flame cutting and chipping shall be done carefully and accurately. Sharp corners and edges that are marred, cut or roughened in handling or erection shall be smoothed by grinding or other approved means.

B1013 ADJOINING ELEMENTS

B1013.1 The Contractor shall be responsible for ascertaining the requirements for adjoining elements to be fixed to, or supported on the steelwork or aluminium, and for providing the required fixings

B1014 FABRICATION

B1014.1 General

B1014.1.1 All work shall be in accordance with the drawings and as per these specifications with care being taken that all parts of an assembly fit accurately together. All members shall carry mark number and item number and, if required, serial number.

B1014.1.2 Unless specifically required under the contract, corresponding parts need not be interchangeable, but the parts shall be match marked as specified in this section.

B1014.1.3 All structural steel members and parts shall have straight edges and blunt surfaces. If necessary, they shall be straightened or flattened by pressure unless they are required to be of curvilinear forms. They shall also be free from twist. Pressure applied for straightening or flattening shall be such as would not injure the materials. Hammering shall not be permitted. Adjacent surfaces or edges shall be in close contact or at uniform distance throughout.

B1014.1.4 The Contractor shall submit his programme of work to the Employer for his approval at least 21 days before the commencement of fabrication. This programme shall include the proposed system of identification and erection marks together with complete details of fabrication, lifting plan and welding procedures.

B1014.1.5 The Contractor shall prepare shop drawings for fabricating any member and obtain approval of the Employer before the start of work. Complete information regarding the location, type, size and extent of all welds shall be clearly shown on the shop drawings. These drawings shall distinguish between shop and field welds.

B1014.2 Preparation of Edges and Ends

B1014.2.1 All structural steel parts, where required, shall be sheared, cropped, sawn or flame cut and ground accurately to the required dimension and shape.

B1014.2.2 End/edge planing and cutting shall be done by any one of the following prescribed methods or left as rolled:

- (a) Shearing, cropping, sawing, machining, machine flame cutting.
- (b) Hand flame cutting with subsequent grinding to a smooth edge.
- (c) Sheared edges of plate not more than 16 mm thick with subsequent grinding to smooth profile, which are for secondary use such as stiffeners and gussets.

B1014.2.3 Wherever specified by the Employer, the flame cut edges shall be ground or machined over and above the requirements. Outside edges of plate and section which are prone to corrosion shall be smoothed by grinding or filing.

B1014.3 Preparation of Holes

B1014.3.1 Drilling and punching: Holes for black bolts, high strength bolts and countersunk bolts (excluding close tolerance and turn fitted bolts) shall be either punched or drilled. The diameter of holes shall be 1.5 mm larger for bolts/rivets less than 25 mm dia and 2.0 mm for more than or equal to 25 mm.

B1014.3.2 All holes shall be drilled except for secondary members such as, floor plate, hand rails etc. Members which do not carry the main load can be punched subject to the thickness of member not exceeding 12 mm for material conforming to IS:2062.

B1014.4 Holes for High Strength Bolts

B1014.4.1 All holes shall be drilled after all left over burrs removed. Where the number of plies in the grip does not exceed three, the diameters of holes shall be 1.6 mm larger than those of bolts and for more than three plies in grip, the diameters of hole in outer plies shall be as above and dia. of holes in inner plies shall be not be less than 1.6 mm and not more than 3.2 mm larger than those in bolts, unless otherwise specified by the Employer.

B1014.5 Removal of Burrs

B1014.5.1 The work shall be taken apart after drilling and all burrs left by drilling and the sharp edges of all rivet holes completely removed.

B1014.6 Black Bolts (black all over)

B1014.6.1 Black bolts are forged bolts in which the shanks, heads and nuts do not receive any further treatment except cutting of screw threads. They shall be true to shape and size and shall have the standard dimensions as shown on the drawings and to be used for erection/placement and alignment of members. These are meant for secondary connection shown in drawings.

B1014.7 High Strength Friction Bolts and Bolted Connections

B1014.7.1 The general requirement shall be as per relevant IS: 800-2007 specifications. Unless otherwise specified by the Employer, bolted connections of structural joints using high tensile bolts shall comply with requirements in IS: 4000.

B1014.8 Washers

B1014.8.1 In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a steel washer under the nut of sufficient thickness to avoid any threaded portion of the bolt being within the thickness of the parts bolted together and to prevent the nut when screwed up, from bearing on the bolt.

- B1014.8.2 Taper washers with correct angle of taper shall be provided under all heads and nuts bearing on beveled surfaces.
- B1014.8.3 Spring washers may be used under nuts to prevent slackening of the nuts when excessive vibrations occur for example, at base of Equipment Foundations.
- B1014.8.4 Where the heads or nuts bears on timber, square washers having a length of each side not less than three times the diameter of bolts or round washers having a diameter of 3 ½ times the diameter of bolts and with a thickness not less than one quarter of diameter shall be provided.
- B1014.9 **Studs**
- B1014.9.1 Ordinary studs may be used for holding parts together, the holes in one of the parts being tapped to take the thread of the stud. Counter-sunk studs may be used for making connections where the surfaces are required to be clear of all obstruction, such as protruding heads of bolts or rivets, studs may also be welded on the steel work in the position required.
- B1014.10 **Service Bolts**
- B1014.10.1 Service bolts shall have the same clearance as black bolts and where it is required that there should be no movement prior to final riveting, sufficient drifts or close tolerance bolts shall be used to locate the work.
- B1014.11 **Tightening Bolts**
- B1014.11.1 Bolted connection joints with black bolts and high strength bolts shall be inspected for compliance of standard requirements.
- B1014.11.2 The Employer shall observe the installation and tightening of bolts to ensure that correct tightening procedure is used and shall determine that all bolts are tightening. Regardless of tightening method used, tightening of bolts should commence at the most rigidly fixed or stiffest point and progress towards the free edges, both in initial snugging and in final tightening.
- B1014.11.3 The tightness of bolts in connection shall be checked by inspection wrench, which can be torque wrench, power wrench or calibrated wrench.
- B1014.11.4 Tightness of 10 percent bolts, but not less than two bolts, selected at random in each connection shall be checked by applying inspection torque. If no nut or bolt head is turned by this application, connection can be accepted as properly tightened, but if any nut or head has turned all bolts shall be checked and, if necessary, re-tightened.
- B1014.12 **Shop Erection and Match Marking**
- B1014.12.1 Before being dispatched, the steel work shall be temporarily erected in the fabrication shop for inspection by the Employer either wholly or in such portion as the Employer may require so that he may be satisfied both in respect of the alignment and fit of all connections.
- B1014.12.2 The steel work shall be temporarily assembled at place of fabrication.
- B1014.12.3 Assembly shall be of full truss or girder, unless progressive truss or girder assembly, full chord assembly, progressive chord assembly or special complete structure assembly is specified by the Employer.

- B1014.12.4 The field connections of main members of trusses, arches, continuous beams, spans, bends, plate girders and rigid frame assembled, aligned, accuracy of holes and camber shall be checked by Employer and then only reaming of sub-size holes to specified size shall be taken up.
- B1014.12.5 After the work has been passed by the Employer and before it is dismantled, each part shall be carefully marked for re-erection with distinguishing marks and stamped with durable markings. Drawings showing these markings correctly shall be supplied to the Employer.
- B1014.12.6 Unloading, handling and storage of steel work as per these specifications shall be the responsibility of the Contractor. The cost of repairs or of rejected material, its removal and the cost of transporting replacement material to the site shall be borne by the Contractor.
- B1014.13 Welding**
- B1014.13.1 All welding shall be done with the prior approval of the Employer and the workmanship shall conform to the specifications of IS: 823 or other relevant Indian Standards as appropriate.
- B1014.13.2 When material thickness is 20 mm or more, a special precaution like preheating shall be taken as laid down in IS: 823. Surfaces and edges to be welded shall be smooth, uniform and free from fins, tears, cracks and other discontinuities. Surface shall also be free from loose or thick scale, slag rust, moisture, oil and other foreign materials. Surfaces within 50 mm of any weld location shall be free from any paint or other material that may prevent proper welding or cause objectionable fumes during welding.
- B1014.13.3 The general welding procedures including particulars of the preparation of fusion faces for metal arc welding shall be carried out in accordance with IS: 9595.
- B1014.13.4 The welding procedures for shop and site welds including edge preparation of fusion faces shall be submitted in writing in accordance with Clause 22 of IS: 9595 for the approval of the Employer before commencing fabrication and shall also be as per details shown on the drawings. Any deviation from above has to be approved by Employer. Preparation of edges shall, wherever practicable, be done by machine methods.
- B1014.13.5 Machine flame cut edges shall be substantially as smooth and regular as those produced by edge planing and shall be left free of slag. Manual flame cutting shall be permitted by the Employer only where machine cutting is not practicable.
- B1014.13.6 Electrodes to be used for metal arc welding shall comply with relevant IS specifications mentioned.
- B1014.13.7 Assembly of parts for welding shall be in accordance with provisions of IS: 9595.
- B1014.13.8 The welded temporary attachment should be avoided as far as possible; otherwise the method of making any temporary attachment shall be approved by the Employer. Any scars from temporary attachment shall be removed by cutting, chipping and surface shall be finished smooth by grinding to the satisfaction of the Employer.

B1014.13.9 Welding shall not be done when the air temperature is less than 10 degrees Celsius. Welding shall not be done when the surfaces are moist, during periods of strong winds or in snowy weather unless the work and the welding operators are adequately protected.

B1014.13.10 For welding of any particular type of joint, welders shall qualify to the satisfaction of the Employer in accordance with appropriate welders qualification as prescribed in any of the Indian Standards IS: 817, IS: 1966, IS: 1393, IS :7307 (part I), IS: 7310 (Part I) and IS: 7318 (part I) as relevant.

B1014.13.11 In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as to avoid distortion and minimise shrinkage stress. All requirements regarding pre-heating of parent material and inter-pass temperature shall be in accordance with provision of IS: 9595. Peening of weld shall be carried out wherever specified by the Employer. If specified, peening may be employed to be effective on each weld layer except first.

B1014.13.12 The peening should be carried out after weld has cooled by light blows from a power hammer using a round nose tool. Care shall be taken to prevent scaling or flaking of weld and base metal from over peening.

B1014.14 Tolerances

B1014.14.1 Tolerances in dimensions of components of fabricated structural steel work shall be specified on the drawings and shall be subject to the approval of the Employer before fabrication. Unless specified, all parts of an assembly shall fit together accurately within tolerances specified in Table given below.

B1014.14.2 A machined bearing surface, where specified by the Employer, shall be machined within a deviation of 0.25 mm for surfaces that can be inscribed within a square of side 0.5 m.

B1014.15 Fabrication Tolerances

Individual Components	
1. Length	
a) Members with both ends finished for contact bearing	+/- 1 mm
b) Individual components of members with end plate connection	+ 0 mm - 2 mm
c) Other members	
(i) Up to 12 m	+/- 2 mm
(ii) More than 12 m	+/- 3.5 mm
2. Width	
a) Width of built-up girders	+/- 3 mm
b) Deviation in the width of members required to be inserted in other members	+ 0 mm - 3 mm

Individual Components	
3. Depth	
a) Deviation in the depths of solid web and open web girders	+ 3 mm - 2 mm
4. Straightness	
a) Deviation from straightness of columns	L/3000 subject to a maximum of 15 mm where L is length of member
i) In elevation	+ 5 mm
ii) In plan	L/1000 subject to a maximum of 10 mm

B1015 ERECTION

B1015.1 General

B1015.1.1 The provisions of this item shall apply to erection of steel structures.

B1015.1.2 The Contractor shall submit erection drawings for approval prior to erection works, erect the structural steel, remove the temporary construction and do all work required to complete the construction included in the contract in accordance with the drawings and the specifications and to the entire satisfaction of the Employer.

B1015.2 Organization and Equipment

B1015.2.1 The Contractor shall submit erection plans prepared by the fabricator, showing a method and procedure of erection, compatible with the details of fabrication.

B1015.2.2 A detailed scheme must be prepared showing stage-wise activities, with complete drawings and working phase-wise instructions. This should be based on detailed stage-wise calculation and take into account specifications and capacity of erection equipment machinery, tools, tackles to be used and temporary working loads as per Codal provisions.

B1015.2.3 The scheme should be based on site conditions e.g. hydrology, rainfall, flood timings and intensity, soil and sub-soil conditions in the river bed and banks, maximum water depth, temperature and climatic conditions and available working space, etc.

B1015.2.4 The scheme should indicate precisely the type of temporary fasteners to be used as also the minimum percentage of permanent fasteners to be fitted during the stage erection. The working drawings should give clearly the temporary jigs, fixtures, clamps, spacer supports, etc.

- B1015.2.5 Unless otherwise provided in the contract, the contractor shall supply and erect all necessary falsework and staging and shall supply all labour, tools, erection plant and other materials necessary to carry out the work complete in all respects.
- B1015.2.6 The Contractor shall supply all bolts, washers, etc. required to complete erection at site with an allowance for wastage, etc., of 12 ½ percent of the net number of field bolts, nuts, washers required.
- B1015.2.7 Prior to actual commencement of erection all equipment, machinery, tools, tackles, ropes, etc. need to be tested to ensure their efficient working. Frequent visual inspection is essential in vulnerable areas to detect displacements, distress, drainages, etc.
- B1015.2.8 Deflection and vibratory tests shall be conducted in respect of supporting structures, launching truss as also the structure under erection and unusual observation reviewed; looseness of fittings is to be noted.
- B1015.2.9 For welded structures, welders' qualifications and skill are to be checked as per standard norms. Non-destructive tests of joints as per designer's directives are to be carried out.
- B1015.2.10 Precision non-destructive testing instruments available in the market should be used for noting various important parameters of the structures frequently and systematic record is to be kept.
- B1015.2.11 Safety requirements should conform to IS: 7205, IS: 7223 and IS: 7269 as applicable and should be a consideration of safety, economy and rapidity.
- B1015.2.12 Erection work should start with complete resources mobilized as per latest approved drawings and after a thorough survey of foundations and other related structural work. In case of work of magnitude, maximum mechanization is to be adopted.
- B1015.2.13 The structure should be divided into erectable modules as per the scheme. This should be pre-assembled in a suitable yard/platform and its matching with members of the adjacent module checked by trial assembly before erection.
- B1015.2.14 The structure shall be set out to the required lines and levels. The stocks and masses are to be carefully preserved. The steelwork should be erected, adjusted and completed in the required position to the specified line and levels with sufficient drifts and bolts. Packing materials are available to maintain this condition. Organized "Quality Surveillance" checks need to be exercised frequently.
- B1015.2.15 Before starting work, the Contractor shall obtain necessary approval of the Employer as to the method adopted for erection, the number and character of tools and plants. The approval of the Employer shall not relieve the Contractor of his responsibility for the safety of his method or equipment or from carrying out the work fully in accordance with the drawing and specifications.

B1015.2.16 During the progress of work, the Contractor shall have a competent Employer or foreman in charge of the work, who shall be adequately experienced in steel erection and acceptable to the Employer.

B1015.3 Handling and Storing of Materials

B1015.3.1 Suitable area for storage of structures and components shall be located near the site of work. The access road should be free from water logging during the working period and the storage area should be on levelled and firm ground.

B1015.3.2 The store should be provided with adequate handling equipments such as road mobile crane, gantries, derricks, chain pulley blocks, winch of capacity as required etc. Stacking area should be planned and have racks, stands sleeper, access tracks, etc., and properly lighted.

B1015.3.3 Storage should be planned to suit erection work sequence and avoid damage or distortion. Excessively rusted, bent or damaged steel shall be rejected. Methods of storage and handling steel whether fabricated or not shall be subject to the approval of the Employer.

B1015.3.4 Fabricated materials are to be stored with erection marks visible, such as not to be contact with earth surface or water and should be accessible to handling equipment.

B1015.3.5 Small fitting hand tools are to be kept in containers in covered stores. All materials, consumables, including raw steel or fabricated material shall be stored specification-wise and size-wise above the ground upon platforms, skids or other supports. It shall be kept free from dirt and other foreign matter and shall be protected as far as possible from corrosion and distortion. The electrodes shall be stored specification-wise and shall be kept in dry warm condition in properly designed racks. The bolts, nuts, washers, and other fasteners shall be stored on racks above the ground with protective oil coating in gunny bags. The paint shall be stored under cover in air-tight containers.

B1015.3.6 IS: 7293 and IS: 7969 dealing with handling of materials and equipments for safe working should be followed. Safety nuts and bolts as directed are to be used while working. The Contractor shall be held responsible for loss or damage to any material paid for by the Employer while in his care or for any damage to such material resulting from his work.

B1016 FORMWORK

B1016.1 The formwork shall be properly designed, substantially built and maintained for all anticipated loads. The Contractor, if required, shall submit plans for approval to the Employer. Approval of the plans, however, shall not relieve the Contractor of his responsibility.

B1017 STRAIGHTENING BENT MATERIAL

B1017.1 The straightening of plates, angles and other shapes shall be done by methods not likely to produce fracture or any injury. The metal shall not be heated unless permitted by the Employer for special cases, when the heating shall not be to a temperature higher than that producing a dark "cherry red" colour, followed by as slow cooling as possible. Following the straightening of a bend or buckle the surface shall be carefully investigated for evidence of fracture. Sharp kinks and bends may be the cause for rejection of material.

B1018 ASSEMBLING STEEL

B1018.1 The parts shall be accurately assembled as shown on the drawings and match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged.

B1018.2 Hammering which will injure or distort the members shall not be done. Bearing surface or surfaces to be in permanent contact shall be cleaned, before the members are assembled. The truss spans shall be erected on blocking, so placed as to give the proper camber. The blocking shall be left in place until the tendon chord splices are fully bolted and all other truss connections pinned and bolted. Bolts in splices of butt joints of compression members and bolts in railings shall not be fastened until the span has been swung.

B1018.3 All joint surfaces for bolted connections including bolts, nuts, washers shall be free from scale, dirt, burrs, other foreign materials and defects that would prevent solid seating of parts.

B1018.4 All fasteners shall have a washer under nut or bolt head whichever is turned in tightening.

B1018.5 Any connection to be bolted shall be secured in close contact with service bolts or with a sufficient number of permanent bolts before the connections are finally bolted. Joints shall normally be made by filling not less than 50 percent of holes with service bolts and barrel drifts in the ratio 4:1. The service bolts are to be fully tightened up as soon as the joint is assembled. Connections to be made by close tolerance or barrel bolts shall be completed as soon as practicable after assembly.

B1018.6 Any connection to be site welded shall be securely held in position by approved methods to ensure accurate alignment, camber and elevation before welding is commenced.

B1018.7 The field welding bolted and pin connection shall conform to the requirements of these specifications as appropriate.

B1018.8 The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting up of parts by moderate use of drifts or by a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Employer and his approval of the method of correction obtained. The correction shall be made in the presence of the Employer.

B1019 FIELD INSPECTION

B1019.1 General

B1019.1.1 All materials, equipment and work of erection shall be subject to the inspection of the Employer who shall be provided with all facilities including labour and tools required at all reasonable times. Any work found defective is liable to be rejected.

B1019.1.2 No protective treatment shall be applied to the work until the appropriate inspection and testing has been carried out. The stage inspection shall be carried out for all operations so as to ensure the correctness of fabrication and good quality. Girder dimensions and camber shall not be finally checked until all welding and heating operations are completed and the member has cooled to a uniform temperature.

B1019.2 Testing of Material

B1019.2.1 Structural steel shall be tested for mechanical and chemical properties as per various IS codes as may be applicable and shall conform to requirements specified in IS: 2062, IS: 11587, IS: 977, IS: 8500 and IS: 961, etc.

B1019.2.2 Bolts, nuts, washers, welding consumables, steel forging, casting and stainless steel shall be tested for mechanical and chemical properties in the appropriate IS Code.

B1019.2.3 Rolling and cutting tolerance shall be as per IS: 1852. The thickness tolerance check measurements for the plates and rolled sections shall be taken at not less than 15 mm from edge.

B1019.2.4 Laminations in plates shall be carried out by ultra-sonic testing or any other specified methods.

B1019.2.5 Steel work shall be inspected for surface defects and exposed edge laminations during fabrication and blast cleaning. Significant edge laminations found shall be reported to the Employer for his decision.

B1019.2.6 Chipping, grinding, machining or ultrasonic testing shall be used to determine depth of imperfection.

B1019.3 Bolted connections:

B1019.3.1 Bolts and bolted connection joints with high strength friction grip bolts shall be inspected and tested according to IS: 4000.

B1019.3.2 The firmness of joint shall be checked by 0.2 mm filler gauge, which shall not go inside under the bolt head by more than 3 mm. There shall not be any gap between members to be bolted.

B1019.3.3 All loose bolts and bolts with cracks, badly formed or deficient heads or with heads which are eccentric with shanks, shall be cut out and replaced.

B1019.3.4 The alignment of plates at all bolted splice joints and welded butt joints shall be checked for compliance with codal requirements.

B1020 WELDING AND WELDING CONSUMABLES

- B1020.1 Welding procedure, welded connection and testing shall be in compliance with codal requirements.
- B1020.2 All facilities necessary for stage inspection during welding and on completion shall be provided to the Employer or their inspecting Authority by manufacturer.
- B1020.3 Adequate means of identification either by identification mark or other record shall be provided to enable each weld to be traced to the welder(s) by whom it was carried out.
- B1020.4 All metal arcs welding shall be in compliance with IS: 9595 provisions.
- B1020.5 The method of inspection shall be in accordance with IS: 822 and extent of inspection and testing shall be in accordance with the relevant standards or in the absence of such a standard, as agreed with the Employer.

B1021 PROCEDURE TESTS

- B1021.1 The Destructive and Non-Destructive test of weld shall be carried out according to IS: 7307 (Part I).
- B1021.2 One or more of the following methods may be applied for inspection or testing of weld:
- (i) Visual Inspection: All welds shall be visually inspected, which should cover all defects of weld such as size, porosity, crack in the weld or in the HAZ (Heat Affected Zone) etc. Suitable magnifying glass may be used for visual inspection. A weld shall be acceptable by visual inspection if it shows that:
 - (a) The weld has no cracks.
 - (b) Thorough fusion exists between weld and base metal and between adjacent layers of weld metal.
 - (c) Weld profiles are in accordance with requisite clauses of IS: 9595 or as agreed with the Employer.
- B1021.3 The weld shall be of full cross section, except for the ends of intermittent fillet welds outside their effective length.
- B1021.4 Magnetic Particle and Radiographic Inspection: Welds that are subject to radiographic or magnetic particle testing in addition to visual inspection shall have no crack.
- B1021.5 Magnetic particle test shall be carried out for detection of crack and other discontinuity in the weld according to IS: 5334.
- B1021.6 Radiographic test shall be carried out for detection of internal flaws in the weld such as crack, piping porosity inclusion, lack of fusion, incomplete penetration, etc. This test may be carried out as per IS: 1182 and IS: 4853.
- B1021.7 Acceptance Criteria: The weld shall be unacceptable if radiographic or magnetic particle testing shows any of the type of discontinuities indicated in the code.

- (a) Ultrasonic Inspection: The Ultrasonic testing in addition to visual inspection shall be carried out for detection of internal flaws in the weld such as cracks, piping porosity inclusion, lack of fusion, incomplete penetration etc. Acceptance criteria shall be as per IS: 4260 or any other relevant IS Specification and as agreed to by the Employer.
- (b) Liquid Penetration Inspection: The liquid penetrant test shall be carried out for detection of surface defect in the weld, as per IS: 3658, in addition to visual inspection.

B1021.8 Any lamination, lamellar tearing or other defect found shall be recorded and reported to Employer for his decision.

B1022 INSPECTION REQUIREMENT

B1022.1 The fabricated member/component made out of rolled and built-up section shall be checked for compliance of the tolerances given in Table given above. Inspection of member/components for compliance with tolerances, and the check for deviations shall be made over the full length.

B1022.2 During checking, the inspection requirement shall be placed in such a manner that local surface irregularities do not influence the results.

B1022.3 For plate, out-of-plane deviation shall be checked at right angle to the surface over the full area of plate.

B1022.4 During inspection, the component/member shall not have any load or external restraint.

B1022.5 Inspection Stages: The inspection to be carried out for compliance of tolerances shall include but not be limited to the following stages:

B1022.6 For completed parts, component/members on completion of fabrication and before any subsequent operation such as surface preparation, painting, transportation, erection.

B1022.7 Where, on checking member/component for the deviations in respect of out-of-plane or out-of-straightness at right angles to the plate surface, and any other instances, exceed tolerance, the maximum deviation shall be measured and recorded. The recorded measurements shall be submitted to the Employer who will determine whether the component/member may be accepted without rectification, with rectification or rejected.

B1023 STAINLESS STEEL

B1023.1 In addition to the general requirements of the following shall apply.

B1023.2 Electrodes for stainless steel shall comply with IS 5206. The Contractor shall undertake the surface preparation, passivation treatment, testing and inspection of all welds in accordance with IS 10117.

B1023.3 Tubular / Hollow Section Trusses/ Structural Steel Tube

These shall be of:

- 1. Hot finished welded (HFW) type, or
- 2. Hot finished seamless (HFS) type, or
- 3. Electric resistance or induction butt welded (ERW), YST 310

- B1023.3.1 Conforming to the requirement of IS 4923. Tubes shall be designed by their nominal bore. These shall be light, medium or heavy as specified depending upon the wall thickness. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut clean and square with axis of tube, unless otherwise specified.
- B1023.4 **Minimum Thickness of Metals**
- B1023.4.1 Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm and for construction not exposed to weather it shall be not less than 3.2 mm where structures are not readily accessible for maintenance; the minimum thickness shall be 5 mm.
- B1023.5 **Fabrication**
- B1023.5.1 The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are, maintained. The tubular steel work shall be painted with one coat of approved steel primer after fabrication. All fabrication and welding is to be done in an approved workshop. The joint details shall be generally as per SP-38 of BIS publication.
- B1023.6 **Straightening**
- B1023.6.1 All material before being assembled shall be straightened, if necessary, unless required to be of curvilinear form and shall be free from twist. The Contractor should arrange for In-situ tests of all stainless steel material to ascertain the quality of material as per IS standards.
- B1023.7 **Bolting**
- B1023.7.1 Washers shall be specially shaped where necessary, or other means, used to give the nuts and the heads of bolts a satisfactory bearing.
- B1023.7.2 In all cases, where the full area of the bolts is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together and washers of appropriate thickness shall be provided to allow the nuts to be completely tightened.
- B1023.8 **Welding**
- B1023.8.1 Where welding is adopted, it shall be as per IS 816.
- B1023.9 **Caps and Bases for Columns**
- B1023.9.1 The ends of all the tubes, for columns transmitting loads through the ends, should be true and square to the axis of the tubes and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

B1023.10 Sealing of Tubes

B1023.10.1 When the end of a tube is not automatically sealed by virtue of its connection be welding to another member the end shall be properly and completely sealed. Before sealing, the inside of the tubes should be dry and free from loose scale.

B1023.11 Flattened Ends

B1023.11.1 In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded. Riveted or bolted connections provide that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

B1023.12 Hoisting and Erection

B1023.12.1 Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workman. The method of hoisting and erection proposed to be adopted shall be got approved from the Employer. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

B1100 PROTECTIVE COATINGS FOR STEELWORKS

B1101 INTRODUCTION

B1101.1 Purpose

B1101.1.1 This Specification defines the technical requirements for protective coatings for the Steel and Civil Works.

B1102 SCOPE

B1102.1 This Specification covers the surface preparation and application of protective coatings to steel surfaces. Steel items to which protective coatings are to be applied include but are not limited to building roof frames and trusses, pipes, pipe and cable supports, platforms, walkways, ladders, stairs and handrails, grating, bollards, miscellaneous steel, holding down and anchor bolts, U bolts for fenders and bolts, nuts and washers.

B1102.2 Surface of grade 316 stainless steels are not required to be protected with a paint system.

B1103 REFERENCE DOCUMENTS

B1103.1 Codes and Standards

B1103.1.1 The following documents are referred to in this Specification:

IS 1367 (Part 13)	Hot-Dip Galvanised Coatings on Threaded Fasteners
IS2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
IS4759	Hot-Dip Zinc coating on Structural Steel and other Allied products
IS8629 (Parts I to III)	Code of Practice for Protection of Iron and Steel Structures from Atmospheric Corrosion
ISO8504:1992	Preparation of steel substrates before Application of Paints and Related Products
ISO8501-1:1988	Preparation of steel substrates before Application of Paints and Related Products-Visual Assessment of surface cleanliness
SSPC-SP10	NACE No. 2, Near white blast cleaning (Sept 1, 2000) (SSPC: The Society for Protective Coatings - US

B1104 TECHNICAL REQUIREMENTS – PROTECTIVE COATINGS

B1104.1 General

B1104.1.1 Surface Preparation and Application of Coats: Application of coatings shall not take place in adverse conditions which shall include:

- (a) Relative humidity greater than 85%
- (b) Substrate temperatures within 3°C of dew point
- (c) Temperatures below 10°C
- (d) Substrate temperatures above 40°C

- (e) High Winds
- (f) Rain
- (g) Possibility of overspray to any property

- B1104.1.2 Prime coatings over bare metal shall be applied within six hours of abrasive blasting and before discolouring or flash rusting occurs.
- B1104.1.3 Intermediate and finish coats shall be applied over previous coats as soon as practical, but within the paint manufacturer's recommendations.
- B1104.1.4 Thinners to enable application of protective coatings, if required, shall be used in the minimum quantity that enables correct application. The Contractor shall obtain approval in writing from the paint manufacturer, for the type of thinners to be used in each type of protective coating.
- B1104.1.5 Safety Protective clothing and equipment shall be used at all times.

B1105 TRANSPORT AND HANDLING

- B1105.1 During transport and handling of coated components, non-chaffing slings, tie downs and supports shall be used to prevent damage to coatings.

B1106 SITE WELDING

- B1106.1 After the completion of any site welding undertaken only with the prior written permission of the Employer, the coating system shall be repaired as per the relevant specified paint system for each component. These repairs shall include abrasive blasting.

B1107 INSPECTION AND TESTING

- B1107.1 The Contractor shall employ an experienced Quality controller approved by the Employer to undertake all quality inspections and testing of preparation and application of protective coatings whether on or off site.
- B1107.2 The contractor shall provide certification to the Employer that all surface preparation and application of protective coatings is in accordance with the Specification and Drawings.
- B1107.3 The paint manufacturer shall be kept informed of all coating applications.

B1108 INSPECTION

- B1108.1 The following inspection requirements shall apply:
- (a) Five (5) working days' notice is to be given to the Employer prior to the commencement of work;
 - (b) Two (2) working days' notice is to be given to the Employer prior to abrasively blasting each item;
 - (c) The Employer, or quality inspector and paint manufacturer shall be afforded free access to inspect work at all times;
 - (d) Surface profiles outside the specified range will not be accepted;
 - (e) Dry film thickness as specified is an absolute minimum. Measurements shall not be averaged. Areas found to be outside the specified dry film thickness shall be rectified to the satisfaction of the Employer.

B1108.2 The wet film thickness of each coat of paint shall be measured to enable modification of the rate of application of the paint, if necessary, before a coating has hardened.

B1108.3 The dry film thickness of the coats and/or completed coating system shall be measured as often as deemed to be necessary to determine whether or not such thickness conforms to the requirements for the particular coating system specified. The dry film thickness of a coat or of a coating system may be measured by pull-off or direct reading instruments based on magnetic attraction or by instruments utilizing electromagnetic induction and eddy current.

B1109 WORKMANSHIP

B1109.1 Workmanship shall be of a standard that will ensure coatings of uniform thickness, free of runs, bubbles, dry overspray, cracking, holidays, inclusions of foreign materials and other defects.

B1110 QUALIFICATIONS

B1110.1 Painting contractors shall be professional applicators qualified to an acceptable industry standard approved by the Employer

B1111 SITE ABRASIVE BLASTING

B1111.1 Blast mediums shall not contain any substance which will contaminate the environment. Garnet shall be used for all site work unless otherwise approved by the Employer.

B1111.2 Blasting shall require the collection of blast and blasted material so it does not enter the environment.

B1111.3 Used blast materials shall be disposed offsite in statutory approved disposal facilities.

B1112 SURFACE PREPARATION

B1112.1 General

B1112.1.1 Unless stated otherwise, the specified level of surface preparation shall apply to all sides of the item and all visible and accessible surfaces that can be prepared to the required standard.

B1112.1.2 Surface preparation and coating should normally be commenced only after all rolling, welding and forming is complete. Items to be primed with a shop primer and taken to site where fabrication and welding continues will require additional coating procedures.

B1112.1.3 All sharp edges and corners shall be ground to a minimum radius of 2.0 mm, and all sharp irregularities, burrs, surface shell, slag and spatter on welds, whether apparent before or after blast cleaning, shall be removed before the commencement of coating application.

B1112.1.4 Temporary welds shall be ground to a flat finish. Weld porosity, if not deemed defective welding, shall be filled with two-component epoxy filler– putty that is compatible with the specified coating system after the surface preparation is complete.

- B1112.1.5 Welds shall be ground to a surface free of peaks and sharp edges.
- B1112.1.6 Surfaces to be coated shall be inspected to determine the presence of oil, grease or other hydrocarbon contamination. If present, use a spirit based cleaner or Acetone solvent to remove any wax crayon or dye penetration marker by solvent washing to the localized area.
- B1112.1.7 Paint solvents (thinners) shall not be used for general degreasing or preparation of the surface for painting.
- B1112.1.8 Larger areas of contaminated surfaces shall be degreased to AS 1627.1 Part 2.4 "Emulsion Processes" or equivalent approved standard using a water-soluble, non-ionic fully biodegradable, alkali based oil emulsifying degreasing agent as approved by the Employer. The surface shall then be washed down to NACE 5 / SSPC-SP 12 using high-pressure water jetting equipment to achieve grade WJ-3 cleaning.
- B1112.1.9 Surfaces not contaminated with hydrocarbon deposits shall be cleaned down by high-pressure water jetting to NACE 5 / SSPC-SP 12 using high-pressure water jetting equipment to achieve grade WJ-3 cleaning.
- B1112.1.10 Abrasive blast cleaning of carbon steel shall be to BS EN ISO 8501-1 to the class of finish specified.
- B1112.1.11 Spent abrasive, old coating, corrosion product etc. shall be removed from the surface by blowing with clean, dry air and/or by vacuum cleaning.
- B1112.1.12 Inspect for particulate contamination to BS EN ISO 8502-3.
- B1112.1.13 Surfaces that become contaminated by flash rusting shall be re-prepared to the original specified standard before coating.
- B1112.1.14 Coatings contaminated with abrasive or other foreign matter will not be allowed.
- B1112.1.15 Blast cleaned surfaces shall be kept free of any contamination and shall not be touched by bare hands, and to this end, operators handling prepared steel shall wear clean gloves.
- B1112.1.16 For steelwork abrasive blast cleaned in or near the open, any wetting from rain or inclement conditions during or after cleaning but before prime coating shall result in the whole segment of steel work affected being re-blast cleaned.
- B1112.1.17 Protective coating shall commence within four (4) hours of blast cleaning or in any case before visual tarnishing of the steel occurs. Surfaces left longer than four (4) hours shall be re-blast cleaned before coating.
- B1112.1.18 The NACE Visual Standard TM-01-07 Pictorial Surface Preparation Standards shall be used as a guide to assess the degree of surface cleanliness.

B1112.2 NACE NO.: 5 / SSPC SP-12 VISUAL SURFACE PREPARATION DEFINITIONS

Condition	Description of surface (no Magnification)
WJ-1	The surface shall be free of all previously existing visible rust, mill scale and coatings and all foreign matter and have an even matte finish.
WJ-2	95% of the surface area will display as for WJ-1 with the remainder containing randomly dispersed stain residues of rust, coatings and mill scale.
WJ-3	At least 66% of the surface area will appear as for WJ-2 while the remaining 34% contain randomly dispersed stains of rust, coatings and mill scale.
WJ-4	The surface shall be free of all loosely adhered coatings; rust and mill scale and have an even appearance.

B1112.3 NACE NO.: 5 / SSPC SP-12 NON VISUAL SURFACE PREPARATION DEFINITIONS

Condition	Description of Surface
SC-1	The surface shall be free of all contaminants when tested using the most appropriate test method for the contaminant required. Contaminants are water-soluble chlorides, iron soluble salts and sulphates.
SC-2	The surface shall contain < 7µg/cm ³ chloride contaminants, <17µg/cm ³ sulphate contaminants, and <10µg/cm ³ soluble ferrous ion levels when tested by the appropriate test methods.
SC-3	The surface shall contain < 50µg/cm ³ of both chloride and sulphate contaminants as tested by the most appropriate test method.

B1112.4 Abrasives

B1112.4.1 Abrasives suitable for surface preparation and cleaning include - chilled iron grit for enclosed blasting operations and garnet for open blasting and site blasting. Only garnet shall be used for abrasive blast preparation of stainless steels. Alternative abrasive media shall not be used unless approved by the Employer.

B1112.4.2 Abrasives shall be used in compliance with all statutory Health and Safety legislation and site requirements.

B1112.4.3 Abrasives are to be dry, angular, and free from oil, grease, dust and foreign matter and shall contain no more than 50 ppm soluble salts (TDS). The abrasive selected shall be suitably graded to provide the surface profile specified.

B1112.4.4 Clean used garnet may be re-cycled and used for an initial blast to remove mill scale and surface contamination but only new garnet shall be used for the final blast prior to coating application. Abrasives used for the removal of coatings that contain lead or asbestos shall not be re-cycled.

B1112.5 Surface Profile of the Substrate

- B1112.5.1 At the commencement and finish of blasting, a surface profile between 35-65 microns shall be produced and measured with Surface Replication (Testex) Tape according to BS EN ISO 8503-5.
- B1112.5.2 Corrosion pitting in excess of 5% of the substrate thickness or areas of significant metal loss and defects that are exposed by the blasting process shall be referred to the Employer for inspection and passed "fit for service" before proceeding with the coating system.

B1112.6 Residual Surface Salts

- B1112.6.1 Surfaces to be abrasive blast cleaned shall be tested for the presence of soluble salts in accordance with BS EN ISO 8502.
- B1112.6.2 Carry out testing for soluble salts prior to commencing blasting so that removal procedures can be initiated before blasting is commenced.
- B1112.6.3 Test results for surfaces that show a soluble salt level above 50 ppm shall require that the total surface area be again washed down with high-pressure water jetting equipment using fresh water. The fresh water used for washing down shall be dosed with a chloride neutralizing solution approved by the Employer. Re-test the treated surface and if the test is a pass, the surface can then be abrasive blast cleaned to the required standard.
- B1112.6.4 Surfaces that develop visual tarnishing (red rust or black spots) at any time before coating shall be re-washed down with fresh water dosed with an approved chloride neutralizing solution and re-blast cleaned prior to coating.

B1113 PROTECTIVE COATING

B1113.1 Surface Preparation

- B1113.1.1 Blast Abrasive Cleaning to Sa2.5 Swedish Standard. Solvent cleaning to be done in case of any oil stains on the surface.

B1113.2 PRIMER

- B1113.2.1 Two pack epoxy Phenylkamine Primer with min Vol. Solid of 63% to give 100 mic DFT per coat having salt spray resistance of 1500 hrs Epilux FRX A/C Coating of Berger or Equivalent

B1113.3 INTERMEDIATE

- B1113.3.1 Two pack epoxy cured with aliphatic amine and having a min vol. solids of 85% to give DFT of 150 microns in single coat. The product must possess 2000 hrs of Salt Spray resistance. Epilux 950 Super HB Coating of Berger or equivalent.

B1113.4 FINISH

B1113.4.1 Two pack aliphatic acrylic PU paint with a min vol solids of 52% and giving a DFT of 50 microns. Product should have 80% gloss level after 1000 hrs of exposure to UV B Lamp. BR ACR PU High Gloss Enamel of Berger or equivalent

B1114 STEEL TO BE HOT-DIP GALVANIZED

B1114.1 General

B1114.1.1 The Contractor shall ensure that the fabricator installs a sufficient number of breather / drain holes where necessary. If necessary, the fabricator shall provide them before galvanizing.

B1114.1.2 The methods employed in the pre-treatment and hot-dip galvanizing process shall be as recommended in BS EN ISO 1461 and these specifications.

B1114.1.3 All sharp edges and corners shall be ground to a minimum radius of 2.0 mm, and all sharp irregularities, burrs, surface shell, slag and spatter on welds, whether apparent before or after blast cleaning, shall be removed before the commencement of coating application.

B1114.1.4 Before galvanizing, all steelwork shall be thoroughly cleaned of all grease, welding flux or any other deleterious substance in accordance with AS 1627.1 2.4 "Emulsion Processes" or equivalent approved standard.

B1114.1.5 Prepare the steel by either blast cleaning to BS EN ISO 8501-1 Sa 2.5 Very Thorough blast cleaning or Acid pickle to remove old paint, mill scale and rust prior to entry to the galvanizing bath.

B1114.1.6 Zinc shall be applied to the steelwork, other than on nut and bolt thread surfaces, at the rate of not less than 550 g/m² and shall average 600 g/m² of surfaces. The weight and quality of the coating shall be checked in accordance with BS EN ISO 1461. The zinc coating shall be free from lumps, blisters, gritty areas, uncoated spots, acid and black spots, dross, flux and other imperfections or faults such as the Kirkendall effect.

B1114.1.7 The dry film thickness of the zinc film shall be checked in accordance with BS EN ISO 2808 for Magnetic Induction and Eddy Current methods.

B1114.1.8 Any galvanizing shown to be defective by inspection or by any of the tests carried out in accordance with the relevant Standards will be cause for rejection.

B1114.1.9 Where the substrate material is damaged during galvanizing, the damaged section shall be replaced or made good.

B1114.1.10 Localized damage to galvanized steel shall be mechanically prepared to BS EN ISO 8501-1 St 3 and repaired by coating with an approved two component zinc rich epoxy coating suitable for the repair of damaged galvanized coatings.

B1114.2 Surface Preparation for Painting after Galvanizing

B1114.2.1 Galvanized surfaces shall be degreased to AS 1627.1 “emulsion process” or equivalent approved standard and lightly abrasive blast cleaned to BS EN ISO 8501-1 Sa1 light blast cleaning to remove all zinc corrosion product, “spangle” and shine and to impart a surface roughness profile no greater than 10 microns.

The following criteria shall be observed:

- (i) Blast pressure 40 psi maximum.
- (ii) Abrasive Grade 0.2 - 0.6 mm.
- (iii) Angle of blasting to surface 45° angle.
- (iv) Distance from surface 300-400 mm.
- (v) Nozzle type min 10mm of venturi type.

B1115 COATING SUPPLY

B1115.1 The names of the materials stated in the materials specification are to be regarded as those which designate the minimum acceptable generic coating type, quality and performance.

B1115.2 Coatings, solvents and coating systems nominated by the contractor in their tender shall be sourced from the one supplier / manufacturer. Mixed systems will be rejected. The coatings shall be fit for use and the intention of these specifications.

B1115.3 If coatings are applied from different manufacturers in a mixed system, the steel thus coated shall be re-blasted and recoated in accordance with these specifications.

B1115.4 All coating materials used in a coating system shall be suitable for the described exposure service and deemed to carry the manufacturer’s assurance of compatibility in the coating sequence as specified.

B1115.5 Should the Contractor wish to nominate alternative coatings or coating systems, he shall clearly mark the submission as “non-conforming” and shall supply a written submission as to why they wish to use an alternative system. The submission shall include the name of the manufacturer, their local representative and relevant industry experience and qualifications, manufacturer’s technical and MSDS data sheets, manufacturer’s alternative specification and case histories for similar exposure conditions as described in the specification scope.

B1115.6 Coatings new to the market that lack suitable case histories for those described in the specification and coatings that are deemed to be experimental or still in a trial period shall not be used. Likewise, experimental surface preparation, coating preparation or application techniques shall not be used without the agreement in writing of the Employer.

B1115.7 Coating systems that do not possess independent testing from a suitably accredited organization for resistance to the phenomena known as Cold Wall Effect will not be approved for use. Coating should meet all ratings for potable contact i.e. permeability, toxicity and leaching requirements.

B1115.8 Before commencing application of any coating, the Manufacturer's certificates for each consignment of material delivered to the job shall be checked and the following data verified for compliance with the requirements of these specifications.

- (i) Description of material.
- (ii) Vendor's Reference Number.
- (iii) Batch Number.
- (iv) Quantity in Batch.
- (v) Date of Manufacture.
- (vi) Manufacturer's stated expiry date.
- (vii) Manufacturers certificate of analysis and batch test certificate.

B1115.9 Coatings supplied for these specifications shall be new and supplied in the manufacturer's original, labelled, unopened sealed containers clearly marked with batch numbers and the product expiry date.

B1115.10 Where practicable, each specified coating shall be of the same batch number.

B1115.11 Coatings should be stored in a cool, dry, ventilated approved flammable store. Coatings shall be used within the manufacturer's stated shelf life or expiry date.

B1116 COATING APPLICATION

B1116.1 General

B1116.1.1 Coatings shall never be applied over a contaminated surface or over moisture on the surface of the substrate or previous coating. Effective controls shall be established to preclude blasting, priming or top coating operations in unsuitable weather.

B1116.1.2 Coatings shall be applied over surfaces prepared to the requirements of these specifications and shall be mixed, thinned and applied in accordance with the coating manufacturers written directions.

B1116.2 Environmental Conditions

B1116.2.1 The Contractor shall not proceed to apply the coatings if the prevailing conditions are outside the manufacturer's written recommendations. The following minimum conditions shall apply:

- (i) Do not apply the coating if the surface is wet or likely to become wet after blasting or before prime coating or top coating.
- (ii) Do not apply the coating if the surface temperature is within 3°C of the dew point.
- (iii) Do not apply the coating if the surface temperature is less than 10°C.
- (iv) Do not apply the coating if the substrate temperature is greater than 45°C.
- (v) Do not apply the coating if the relative humidity is greater than 85%.
- (vi) Do not apply the coating if the weather is clearly deteriorating or unfavourable for application or curing.
- (vii) Do not apply the coating in high wind conditions.

(viii) Do not stand the coating in direct sunlight before mixing or adding the converter (catalyst).

B1116.3 Application

- B1116.3.1 Multi-component coatings shall be combined as whole pack units. Partial mixing of component packs is prohibited. This instruction does not apply to materials applied by plural component equipment, where the manufacturers mixing instructions are to be followed.
- B1116.3.2 Addition of thinners (reducers) shall be strictly as per the manufacturer's technical data sheet limits for the specified product. When adding thinners to a coating the thinner volume shall be measured and recorded to the daily painting records. The addition of thinner by "eye measurement" is prohibited.
- B1116.3.3 The Contractor shall take care to ensure that areas adjacent to the painting area are protected from overspray, paint and solvent emissions, abrasive over-blast or other actions that may cause damage. Contractor shall erect screens, barriers and masking as appropriate to ensure suitable protection is provided.
- B1116.3.4 Prior to the spray application of the primer and first intermediate coat, all edges, bolts and bolt holes (including slots) shall be stripe coated by brush method.
- B1116.3.5 Coatings shall be applied in the sequence as specified in accordance with these specifications and the manufacturer's technical data sheets.
- B1116.3.6 Where the same or similar coatings form a "coating system", each additional coat shall be of a different colour to the preceding coat to allow the Contractor a clear visual guide when over coating.
- B1116.3.7 The Contractor shall observe all ITP hold and witness points.
- B1116.3.8 The Contractor shall use an approved Wet Film Gauge (notched comb) in accordance with BS EN ISO 2808 during application to minimise the possibility of low and high dry film thicknesses.
- B1116.3.9 The Coating manufacturer's technical data sheet shall be consulted for advice regarding cure intervals. The specified re-coating windows for temperature and time shall be observed to avoid over coating inside or outside the correct re-coat window.
- B1116.3.10 Coatings that have been allowed to cure past the manufacturer's re-coat window shall be abraded by hand, mechanical machine or by abrasive "brush blast" methods to roughen the coating and impart a profile before over coating. Refer to the manufacturer's technical data sheet for specific instructions.
- B1116.3.11 Joins, back to back angle or mating surfaces shall be sealed with a suitable sealant after the coating has been applied.

B1117 REPAIR OF DAMAGED COATING

B1117.1 Coatings that become damaged shall be repaired as per the published repair and re-coating instructions in the relevant manufacturer's Technical Data Sheet.

B1117.2 Repairs shall return the coating to a uniform film. Repairs shall conform to the specification for surface preparation, application, sequencing, finish and dry film thickness.

B1118 INSPECTION & QUALITY ASSURANCE

B1118.1 General

B1118.1.1 The Contractor shall have in place and use a Quality Assurance system that conforms to ISO 9000 Quality Standards.

B1118.1.2 The Contractor shall nominate a suitably qualified person to the Employer as the Contractor's Quality Assurance officer for this part of the Works.

B1119 INSPECTION AND TEST PLAN

B1119.1 The Contractor's ITP shall nominate the following minimum hold and witness points:

- (i) Upon receipt of the fabrication to check for all surface defects, including cracks, laminations, deep pitting, weld spatter slag, burrs, fins, sharp edges, coarse welds, porosity, undercuts, slag, weld roughness and other defects. These shall be removed prior to the preparation of the surface to be coated.
- (ii) Carry out a visual surface check for oil and other contamination and degreasing as necessary prior to surface preparation.
- (iii) After surface preparation as required in the specification
- (iv) After the application of each coat of paint to determine thickness, quality and any repairs needed.

B1120 INSPECTION

B1120.1 The Contractor shall inspect each individual coating layer of the coating system and shall ensure that the following conditions are satisfied:

- (i) The uniformity, colour, gloss and opacity are satisfactory.
- (ii) The coating is free from sags, runs, wrinkles, fat edges, mud cracking, blistering, pinholes, dry spray, heavy brush marks and excessive film builds.
- (iii) Adequate coverage has been achieved on corners, crevices, edges and surface where the spray gun cannot be positioned so that its spray impinges on the surface at 90° to the surface.
- (iv) There is the required adhesion to the substrate and between coating layers.
- (v) The coating is free from defects, discontinuities, insects, dry spray, spent abrasive media and other contamination.
- (vi) The individual coats of the coating system and the complete coating system has the specified dry film thickness.

- (vii) The coating has not been adversely affected by rain or any other agency during curing.
- B1120.2 The Contractor shall maintain proper records of the coating activities as required by the Specification. These records shall include pro-forma inspection records and reports similar in content to those contained in Australian Standard AS3894 Parts 10, 11, 12, 13 and 14 or Indian Standard and any additional records as required by the Employer. Such records shall be available for inspection at any time by the Employer or authorized representative and become the property of the Employer upon completion of the Contractor's obligation.
- B1120.3 The Contractor shall advise the inspector in sufficient time to enable attendance at the work site without causing unnecessary delay or hindrance to the progress of work.
- B1120.4 The absence of the Employer and / or authorized representative does not absolve the Contractor from carrying out the tasks and the required quality inspection and documentation in accordance with these specifications.
- B1120.5 Work deemed by the Employer as non-conforming to these specifications shall be corrected to conform to the requirements of these specifications. All costs associated with rectification work shall be borne by the Contractor.
- B1120.6 The Contractor shall provide all coating and environmental testing equipment to meet the Contractors quality procedures. Where appropriate, such equipment shall be certified as being calibrated as required by the standards.
- B1121 DRY FILM THICKNESS MEASUREMENTS**
- B1121.1 Dry Film Thickness (DFT) of the coating shall be carried out in accordance with BS EN ISO 2808 for Magnetic Induction and Eddy Current methods. The previously recorded surface profile must be deducted from all DFT readings when required to test the DFT of coatings 150µm and less.
- B1121.2 Dry film thickness inspection of the coating shall include areas of the structure which are difficult to paint, are masked by structure, or areas where double coating or light coating is likely due to the shape of the substrate.
- B1121.3 Contractor shall perform a sufficient number of dry film thickness readings in such a manner as to ensure a representative account for the DFT compliance of the coated area inspected. The method as described in AS 3894.3 Section 7 "Inspection Plans" shall be used as a minimum requirement for a thickness testing plan.
- B1121.4 Inspection by other authorized party(s) that finds discrepancies to the Contractor's recorded findings by way of under-film or over-film DFT readings shall be marked up and re-checked by both parties after calibrating test instruments to the same certified calibration standards. Confirmation of coated areas that fail to meet the specification shall be re-worked and the surface preparation and coatings shall be carried out in the same order as the original work was specified.

B1122 FILM CONTINUITY

B1122.1 Coating System E as specified in this section shall be tested for film continuity and defects including pinholes misses and damage as described in AS3894- Part 1 or Part 2.

B1123 SCOPE OF WORK

B1123.1 All steelwork to be incorporated into the completed works shall be given protective treatment (unless specified otherwise) as specified herein. These specifications cover the surface preparation and application of protective coatings to all steelwork except piles.

B1123.2 The different systems of protective treatment required for steelwork are described in the following clauses. The table below generally describes the system type and the items to which it shall be applied.

B1123.3 PROTECTIVE TREATMENT SCHEDULE

Coating System	General Description	Structural Item
A	Hot Dip Galvanised (HDG)	- Bolts, anchors, nuts, washers, fasteners and anchor plates (UNO) - Roadway safety barrier and posts - Catwalk walkway gratings - Light masts, accessories and attachments (excluding luminaires) - Crane buffers
B	HDG + Paint	- Protective bollards
C	Epoxy Zinc Rich and High Solids Epoxy MIO Paint	- Mooring bollards
D	Epoxy Zinc Rich and High Solids Epoxy MIO Paint	- All other exposed structural steel (UNO)
E	Ultra-High Build Epoxy Paint	- Fender frontal frames

B1124 SURFACE PREPARATION & COATING SYSTEM

B1124.1 Surface Preparation - Mild Steel

- B1124.1.1 Surfaces to be coated shall be inspected to determine the presence of oil, grease or other hydrocarbon contamination. If present, use a spirit based cleaner or acetone solvent to remove any wax crayon or dye penetration marker by solvent washing to the localized area. Wear solvent proof gloves and eye protection.
- B1124.1.2 Paint solvents (thinners) shall not be used for general degreasing or preparation of the surface for painting.
- B1124.1.3 Larger areas of contaminated surfaces shall be degreased to AS 1627.1-2003 Part 2.4 Emulsion Processes or equivalent approved standard, using a water-soluble non-ionic fully biodegradable, alkali based oil emulsifying degreasing agent such as Gamlen CA 1 or other as approved by the Employer. Apply the degreasing solution to the manufacturers recommended method and agitate the surface to activate the cleaner. The surface shall then be washed down to NACE 5 / SSPC-SP 12 to achieve grade WJ-3, SC2* cleaning. Washing water shall be clean and not contain more than 50 ppm of dissolved chloride.
- B1124.1.4 Surfaces not contaminated with hydrocarbon deposits shall be cleaned down by high pressure water jetting to NACE 5 / SSPC-SP 12 using high-pressure water jetting equipment to achieve grade WJ-3, SC2 cleaning. Washing water shall be clean and not contain more than 50 ppm of dissolved chloride.
- B1124.1.5 Inspect the surface to ensure no weld spatter, porous and irregular welds, welding slag, laminations or other sharp protrusions or discontinuities that would be detrimental to the coating system are left on the surface. If present, these defects must be removed before the surface preparation commences. Steel laminations and any other imperfections such as impact damage and gouges should be dressed and filled with metal and then ground flush prior to commencing the Abrasive Blasting Process.
- B1124.2 Edges shall be de-burred and rounded to a minimum 2mm radius.
- B1124.2.1 At the commencement and end of blasting, surface profile readings shall be taken using surface replication tape (Testex) tape to ensure that the specification is being achieved. A surface profile between 50-75 microns shall be produced and measured according to BS EN ISO 8503-5.
- B1124.2.2 Recorded profile on the "Testex" tape shall be used to take a permanent record of the achieved blast profile and these records shall be added to the Contractor's daily work records.
- B1124.2.3 Surface shall then be dry abrasive blast cleaned to the specified class of blast in accordance with BS EN ISO 8501-1.
- B1124.2.4 Inspect for particulate contamination to BS EN ISO 8502-3.

- B1124.2.5 Weld porosity, corrosion pitting or areas of significant metal loss and defects that are exposed by the blasting process shall be referred to the Employer or their representative for inspection and passed "fit for service" before proceeding with the coating system. Weld porosity passed for service shall be filled with two-component epoxy filler/ putty compatible with the coating system prior to application of the primer coat.
- B1124.2.6 Prepared surfaces shall then be tested for residual metallic salts and chemical chlorides as per BS EN ISO 8502.
- B1124.2.7 Test results for surfaces that show a soluble salt level above 50 ppm shall require that the total surface area be again washed down with high-pressure water cleaning equipment using fresh water that has been dosed with an approved chloride neutralizing solution. The dilution shall be according to the manufacturer's written instructions. The surface shall then be re-blasted, as per these specifications and the surface shall then be re-tested for soluble salts.
- B1124.2.8 Initial coating shall commence within four hours of blast cleaning or in any case before visual tarnishing of the steel occurs. Surfaces left longer than four hours shall be re-blast cleaned before coating. Surfaces that develop visual tarnishing (red rust or black spots) at any time before coating shall be re-washed down with fresh water dosed with an approved chloride neutralizing solution and re-blast cleaned prior to coating. Avoid handling blast cleaned steel with bare hands. Operators should use clean gloves to avoid contamination of the surface.
- B1124.3 **Surface Preparation - Hot-dip Galvanized Steel to be Painted**
- B1124.3.1 New Galvanizing needs to be cleaned, dulled and surface profiled before coating to provide a surface that will allow adhesion of the coating. Galvanizing can be prepared by hand methods or by abrasive blast cleaning methods to achieve the desired surface preparation. The type of preparation used will often be controlled by the size of the item, location and other environmental or exposure restrictions. The most thorough, practical method shall be used at all times. In all cases the prepared surface shall be dull, show no "spangle" and shall have a sufficient surface scratch pattern or surface profile to promote adhesion of the applied coating.

- B1124.3.2 Galvanized surfaces to be coated shall be de-greased using a non-ionic, water-soluble, fully biodegradable, alkali based oil emulsifying degreasing agent such as Gamlen CA No.1 or as approved by the Employer. Apply the degreasing solution to the manufacturers recommended dilution and method. Agitate the surface by manually scrubbing with suitable stiff bristle brushes or by hand using a “Scotchbrite No. 96 Green hand Pad” or equivalent. Rinse the surface with potable water and dry. Alternatively, apply an approved degreasing solution as per the manufacturers written instructions and then use water-cleaning equipment that can deliver 5,000 psi (345 Bar) at the nozzle to agitate, clean and fully rinse off the degreasing solution and contamination. Paint solvents (thinners) shall not be used for degreasing or preparation of the galvanized surface for painting.
- B1124.3.3 The surface shall then be abrasive “brush blast” cleaned to BS EN ISO 8501-1 Sa 1 “light blast cleaning” using garnet mineral as the blast media to fully dull and to profile the surface of the galvanizing.
- B1124.3.4 The requirements for abrasive blast preparation of HDG steel prior to coating are summarized as follows:
- (i) Blast pressure 40 psi maximum.
 - (ii) Abrasive Grade 0.2 - 0.6mm (GMA Premium or Speed Blast Garnet).
 - (iii) Angle of blasting to surface 45° angle.
 - (iv) Distance from surface 300-400 mm.
 - (v) Nozzle type min 10mm of venturi type.
- B1124.3.5 Finished surfaces shall be dull, profiled and show no areas of shiny metal. Do not handle the prepared surface with bare hands. Apply the initial coating within two (2 No's) hours of completing the blasting.
- B1124.3.6 Galvanized surfaces to be coated that cannot be abrasive Brush Blast cleaned shall be de-greased using a non-ionic, water-soluble, fully biodegradable, alkali-based oil emulsifying degreasing agent such as Gamlen CA No.1 or as approved by the Employer. Apply the degreasing solution to the manufacturers recommended dilution and method. Agitate the surface to activate the cleaner using a “Scotchbrite No. 96 Green hand Pad” or equivalent to apply a scratch pattern to the Galvanized surface. Rinse the surface with fresh (potable) water and dry. Do not handle the prepared surface with bare hands. Surfaces shall be inspected to ensure no surface contamination remains and that the surface is dull and shows no polished finish. If visible, repeat the process to ensure a sound surface for the primer coat. Apply the primer coating immediately after drying the surface.

B1125 APPROVED COATING SYSTEMS AND COATING MANUFACTURERS

- B1125.1 The following coating systems and coating manufacturers are approved for these specifications.
- B1125.2 **Coating System A:** Surface preparation and application of hot dip galvanized coating to prepared steel substrate in accordance with BS EN ISO 1461 and the requirements of these specifications.

B1125.3 **Coating System B:** Surface preparation and application of hot dip galvanized coating to prepared steel substrate in accordance with BS EN ISO 1461 and the requirements of these specifications for steel to be hot dip galvanized.

B1125.4 This shall be followed by additional surface preparation and application of protective coating to hot dip galvanized substrate in accordance with the requirements of these specifications and as specified in the following table:

B1125.5 **PROTECTIVE COATING SYSTEM B**

Coating System B					
Scope:	As noted under Scope of Works				
Surface Preparation	Degrease, wash and abrasive brush blast to BS EN ISO 8501-1 Sa 1 in accordance with the requirements of these specifications for surface preparation of hot dip galvanized steel to be painted.				
Coating Sequence	Product Description	Dry Film Thickness Range (Microns)*		Approved Coating Manufacturers	
		Min	Max		
Primer Coat:	Epoxy Zinc Phosphate	50	75	Dulux	PPG Industries
Intermediate Coat:	High Solids Epoxy MIO	100	150	Durepon P14	370 ZP
Finish Coat:	High Gloss Polyurethane	60	75	Ferreko No. 3 MIO	Amerlock 400 2K MIO
System DFT Min - Max		210	300	Luxathane R	Amershiel d

* Dry film thickness range is a guide only. Applicator shall use the selected coating manufacturers recommended coating thickness range as detailed on the manufacturers Technical Data Sheet

B1125.6 The intermediate coat shall be a different colour to the primer and the finish coat. The finish coat colour shall be as advised by the Employer. The following colours are advisory only:

- (i) Primer: As supplied.
- (ii) Intermediate: MIO Bridge Grey or Mid Grey.
- (iii) Finish: BS 381C No. 356 Golden Yellow.

B1125.7 **Coating System C:** Surface preparation and application of protective coating to prepared steel substrate in accordance the requirements of these specifications and as specified in the following table:

B1125.8 **PROTECTIVE COATING SYSTEM C**

Coating System C					
Scope:	As noted under Scope of Works				
Surface Preparation	Degrease, wash and abrasive blast to BS EN ISO 8501-1 Sa 2 1/2 “very thorough blast cleaning” in accordance with the requirements these specifications for mild steel.				
Coating Sequence	Product Description	Dry Film Thickness Range (Microns)*		Approved Coating Manufacturers	
		Min	Max		
Primer Coat:	Epoxy Zinc Rich	50	75	Dulux	PPG Industries
Intermediate Coat:	High Solids Epoxy MIO	100	150	Zincanode 202	Amercoat 68 K
Finish Coat:	High Gloss Polyurethane	60	75	Ferreko No. 3 MIO	Amerlock 400 2K MIO
System DFT Min - Max		210	300	Luxathane R	Amershield

* Dry film thickness range is a guide only. Applicator shall use the selected coating manufacturers recommended coating thickness range as detailed on the manufacturers Technical Data Sheet

B1125.9 The intermediate coat shall be a different colour to the primer and the finish coat. The finish coat colour shall be as advised by the Employer. The following colours are advisory only:

- (i) Primer: As supplied.
- (ii) Intermediate: MIO Bridge Grey or Mid Grey.
- (iii) Finish: Gloss Black.

B1125.10 **Coating System D:** Surface preparation and application of protective coating to prepared steel substrate in accordance the requirements of these specifications and as specified in the following table:

B1125.11 PROTECTIVE COATING SYSTEM D

Coating System D					
Scope:	As noted under Scope of Works				
Surface Preparation	Degrease, wash and abrasive blast to BS EN ISO 8501-1 Sa 2 1/2 “very thorough blast cleaning” in accordance requirements of these specifications for mild steel.				
Coating Sequence	Product Description	Dry Film Thickness Range (Microns)*		Approved Coating Manufacturers**	
		Min	Max		
Primer Coat:	Epoxy Zinc Rich	50	75	Dulux	PPG Industries
Intermediate Coat:	High Solids Epoxy MIO	100	150	Zincanode 202	Amercoat 68 K
Finish Coat:	High Solids Epoxy MIO	100	150	Ferreko No. 3 MIO	Amerlock 400 2K MIO
System DFT Min - Max		250	375	Ferreko No. 3 MIO	Amerlock 400 2K MIO

* Dry film thickness range is a guide only. Applicator shall use the selected coating manufacturers recommended coating thickness range as detailed on the manufacturers Technical Data Sheet

B1125.12 The intermediate coat shall be a different colour to the primer and the finish coat. The finish coat colour shall be as advised by the Employer. The following colours are advisory only:

- (i) Primer: As supplied.
- (ii) Intermediate: MIO Natural Steel Grey.
- (iii) Finish: MIO Mid Grey or Bridge Grey.

B1125.13 **Coating System E:** Surface preparation and application of protective coating to prepared steel substrate in accordance the requirements of these specifications and as specified in the following table.

B1125.14 PROTECTIVE COATING SYSTEM E

Coating System E					
Scope:	As noted under Scope of Works				
Surface Preparation	Degrease, wash and abrasive blast to BS EN ISO 8501-1 Sa 3 “blast cleaning to visually clean steel” in accordance requirements of these specifications for mild steel.				
Coating Sequence	Product Description	Dry Film Thickness Range (Microns)*		Approved Coating Manufacturers	
		Min	Max		
Primer Coat:	None	-	-	Dulux	International / AkzoNobel
Intermediate Coat:	None	-	-	-	-
Finish Coat:	Ultra-High Build Epoxy	2,000	2,200	-	-
System DFT Min - Max		2,000	2,200	Luxepoxy UHB	Interzone 485 UHB

B1125.15 The finish coat colour shall be as advised by the Employer. The following colours are advisory only:

- (i) Finish: Grey.

B1126 SUMMARY OF HOLD POINTS

- (i) Pre-Works. Acceptance of Contractor’s submissions regarding proposed protective coatings sub-contractor and proposed paint manufacturer, products, SWMS and ITP.
- (ii) At the conclusion of the surface preparation. Visual acceptance to photographic standards as per and recording of surface profile.
- (iii) At the conclusion of primer coat. Visual acceptance and dry film thickness testing.
- (iv) Conclusion of intermediate coat. Visual acceptance and dry film thickness testing
- (v) Conclusion of finish coat. Visual acceptance and dry film thickness testing.
- (vi) Conclusion of any repairs to damaged coating or repairs to pinhole defects. Visual acceptance and dry film thickness testing

B1127 TESTS AND STANDARDS OF ACCEPTANCE

B1127.1 General

- B1127.1.1 The materials shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, shall be got carried out by the Contractor at his own cost.
- B1127.1.2 The fabrication, furnishing, erecting, painting of structural steel work shall be in accordance with these specifications and shall be checked and accepted by the Employer.

B1200 BUILDING WORKS

B1201 CIVIL WORKS

B1201.1 Concrete block Masonry

B1201.1.1 Concrete block of M15 grade, hollow (open or closed cavity) or solid shall be referred to by its nominal dimensions. The IS 2185 (Part 1) :2005 term nominal means that the dimension includes the thickness of the mortar joint. Actual dimensions (length and depth only) shall be 10 mm short of the nominal dimensions.

The nominal dimensions of concrete block shall be as follows:

Length: 300,400, 500 or 600 mm

Height: 200 or 100 mm

Width: 50,75, 100, 150,200, 250 or 300 mm.

B1201.1.2 In addition, block shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to the full lengths. Full length and half length U-blocks may also be manufactured for the purposes of band and lintels. The nominal dimensions of the units are so designed that taking account of the thickness or mortar joints, they will produce wall lengths and heights which will conform to the principles of modular co-ordination. Blocks of sizes other than those specified herein above may also be used by mutual agreement between the Employer and the Contractor. In the case of special concrete masonry units such as jallie wall blocks and ornamental blocks, the specified sizes may not necessarily apply.

B1201.1.3 The variation in the length of the units shall not be more than* 5 mm and variation in height and width of units, not more than + 3 mm.

B1201.2 Materials

B1201.2.1 Cement: Cement complying with any of the following Indian Standards may be used: 53 grade ordinary Portland cement, conforming to 1S 12269

B1201.2.2 Aggregates: The aggregates used in the manufacture of blocks at the mixer or the mixing platform shall be clean and free from deleterious matter and shall conform to the requirements of IS 383.The grading of the combined aggregates shall conform as near as possible to the requirements indicated in IS 383. Fly ash conforming to IS 3812 (Part 2) may be used for part replacement of fine aggregate upto a limit of 20 percent

B1201.2.3 Water: The water used in the manufacture of concrete masonry units shall be free from matter harmful to concrete or reinforcement or matter likely to cause efflorescence in the units and shall conform to the requirements of IS 456.

B1201.2.4 Additives or Admixtures: Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to the concrete mix. Additives or admixtures used in the manufacture of concrete masonry units may be: Where accelerating, water reducing, air-entraining and super plasticizer conforming to IS 9103, waterproofing agents conforming to IS 2645, and colouring pigments. no Indian Standards apply; the additives or admixtures shall be shown by test or experience, to be not detrimental to the durability of the concrete.

B1201.3 **Manufacture**

B1201.3.1 Mix: The concrete mix used for blocks shall not be richer than one part by volume of cement to 6 parts by volume of combined aggregates before mixing. In machine-moulded blocks, the web markings on the units as they come from the machine give a good indication as to whether the proper consistency of concrete has been used. In addition to the grading of the aggregate and the quantity of the cement, the amount of water required for mix will depend to an extent on the type of machine on which blocks are produced. The amount of water required for mix should be electronically measured and controlled in the mixing drum.

B1201.3.2 Mixing: Batching of the ingredients should be done accurately and concrete mixing shall be done in a mixer to achieve homogeneous mix. Mixing shall be continued until there is a uniform distribution of the materials, and the mass is uniform in colour and consistency.

B1201.3.3 Placing and Compaction: The block should be compacted by compaction and finished to proper size -without broken edges. After ejection demoulding, the “blocks shall be handled carefully to avoid damage. The blocks shall be protected until they are sufficiently hardened before starting curing.

B1201.3.4 Curing: The blocks hardened as above shall then be cured as per 13.5 of IS 456 or by mist curing so as to deliver the specified strength of block. The blocks may alternatively be cured by steam.

B1201.3.5 Drying: After curing the blocks as above, they shall be dried for a period of 4 weeks before being used on the work. In case of curing by steam, once low-pressure steam curing has been done, the blocks shall be dried at ambient temperature for a period of seven days. The blocks shall then be stacked with voids horizontal to facilitate through passage of air. It shall be ensured that the blocks have been thoroughly dried and allowed to complete their initial drying shrinkage before supply to the work-site.

B1201.4 **Surface Texture and Finish**

B1201.4.1 Concrete masonry units can be given a variety of surface textures ranging from a very fine close texture to a coarse open texture by the proper selection grading and proportioning of aggregates at the time. IS 2185 (Part 1): 2005 of manufacture. Textures may also be developed by treating the face of the units while still-green by wire brushing or combing, slightly eroding the surface by playing a fine spray of water upon it, and by splitting (split block). Colour maybe introduced by incorporating non-fading mineral pigments in the facing concrete, or by applying a coloured cement grout or paint to the face of the units soon after they are removed from the moulds. Selected coloured aggregates may also be used in the facing and exposed by washing with water or dilute hydrochloric acid followed by thorough washing with water to ensure no traces of acid are left on the surface. Well made concrete masonry may not require plaster in case of unimportant buildings in low rainfall areas; two or three coats of a cement paint being sufficient to render it resistant to rain water. If, however, it is intended to plaster concrete masonry, the block shall have a sufficiently rough surface to afford a good key to the plaster. Water proofing admixtures may be used for preparing the plaster.

B1201.5 **Physical Requirements**

B1201.5.1 General: All units shall be sound and free of cracks or other defects which interfere with the proper placing of the unit or impair the strength or performance of the construction. Minor chipping resulting from the customary methods of handling during delivery, shall not be deemed grounds for rejection. Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks, or other imperfections, except that if not more than 5 percent of a consignment contains slight cracks or small chippings not larger than 25 mm, this shall not be deemed grounds for rejection.

B1201.5.2 Dimensions: The overall dimensions of the units when measured as given above shall in accordance with IS 2185 (Part 1): 2005 subjects to the tolerances mentioned therein.

B1201.5.3 Blocks Density: The block density when determined as per code shall conform to the requirement.

B1201.5.4 Compressive Strength: The minimum compressive strength at 28 days being the average of eight units, and the minimum compressive strength at 28 days of individual units, when tested in the manner described in code.

B1201.5.5 Water Absorption: The water absorption, being the average of three units, when determined in the manner prescribed in code shall not be more than 10 percent by mass.

B1201.5.6 Drying Shrinkage: The drying shrinkage of the units when unrestrained being the average of three units, shall be determined in the manner described in code and shall not exceed 0.06 percent.

B1201.5.7 Moisture Movement: The moisture movement of the dried blocks on immersion in water, being the average of three units, when determined in the manner described in code, shall not exceed 0.09 percent.

B1201.6 Tests

B1201.6.1 Tests shall be conducted on samples of units selected according to the sampling procedure to ensure conformity with the physical requirements.

B1201.7 Sampling

B1201.7.1 The blocks required for carrying out the tests laid down in this standard shall be taken by one of the methods given code. In either case, a sample of 20 blocks shall be taken from every lot/consignment of 5000 blocks or part thereof from the same grade, size and same batch of manufacture.

B1201.7.2 The required number of blocks shall be taken at regular intervals during the loading of the vehicle or the unloading of the vehicle depending on whether sample is to be taken before delivery or after delivery. When this is not practicable, the sample shall be taken from the stack in which case the required number of blocks shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks by opening trenches from the top. The sample of blocks shall be marked for future identification of the consignment it represents. The blocks shall be kept under cover and protected from extreme conditions of temperature, relative humidity and wind until they are required for test. The tests shall be undertaken as soon as practicable after the sample has been taken.

B1201.8 Number of Tests

B1201.8.1 All the 20 blocks shall be checked for dimensions and inspected for visual defects. Out of the 20 blocks, 3 blocks shall be subjected to the test for block density, 8 blocks to the test for compressive strength, 3 blocks to the test for water absorption, and 3 blocks to the test for drying shrinkage and later to the test for moisture movement. The remaining 3 blocks shall be reserved for retest for drying shrinkage and moisture movement, if a need arises.

B1201.9 Criteria for Conformity

B1201.9.1 The lot shall be considered as conforming to the requirements of the specification if the conditions mentioned in code are satisfied. The number of blocks with dimensions outside the tolerance limit and/or with visual defects, among 1S 2185 (Part 1) :2005 those inspected shall be not more than two, for block density, the mean value determined shall be greater than or equal to the minimum limit specified in code. For compressive strength, the average value and minimum individual value determined shall be greater than or equal to the value specified in code. For drying shrinkage and moisture movement, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements. For water absorption, the mean value determined shall be equal or less than maximum limit specified in code.

B1201.10 Manufacturer's Certificate

B1201.10.1 The manufacturer shall satisfy himself that the masonry units conform to the requirements of this standard and, if requested, shall supply a certificate to this effect to the Employer or his representative.

B1201.11 Independent Tests

B1201.11.1 If the Employer or his representative requires independent tests, the samples shall be taken before or immediately after delivery, at the option of the Employer or his representative and the tests shall be carried out in accordance with this standard. The manufacturer shall supply free of charge the units required for testing.

B1201.12 Cost of Testing

B1201.12.1 Unless otherwise specified in the enquiry or order, the cost of the tests shall be borne by the Contractor.

B1201.13 Marking

B1201.13.1 Concrete masonry units manufactured in accordance with this specification shall be marked permanently with the following information:

B1201.13.2 Identification of the manufacturer; Grade of the unit; and Year of manufacture, if required by the Employer.

B1202 RUBBLE MASONRY

B1202.1 Stones for this work shall be hard, durable rock, close or fine grained and uniform in colour free from veins, flaws and other defects and shall conform to IS:1597 (Part I). The stones shall be laid in mortar proportions specified for the particular item of work. Stones shall be got approved.

B1202.2 For all work below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones or hearting and faced with selected quarry dressed stones. For all work above ground level the masonry shall be random rubble faced with hammer dressed stones with squared quoins at joints and corners. No stones shall tail into the wall, either with a point or to length less than 1.5times its height.

B1202.3 The thickness of the joints shall not exceed 12 mm. Spalls and pinnings shall not be allowed to show on the face of the wall. Two bond stones each of minimum area of 500 sq.cm for every 1.0 sq.m. of each wall face shall be provided. These shall be through stones in walls 600 mm thick and under, in walls thicker than 600 mm the length of bond stones shall be 2/3 times the thickness of walls. The stones for hearting of the wall shall not be less than 150 mm in any direction. Chips and spalls shall be wedged in to avoid thick mortar beds and joints. The wall faces, corners and joints or openings shall be truly vertical the quoins shall be of selected stones, neatly dressed with chisel to form the required angle and laid header and stretcher alternatively. The exposed face of the work shall be carefully and neatly pointed with mortar in all joints on the other side the joints shall be neatly struck with trowel while the mortar is fresh. The mortar for the work shall be as specified in the respective item of work. Curing of masonry shall continue for a minimum of ten days.

B1203 FLUSH DOOR

B1203.1 General

B1203.1.1 Wood used for all work shall be the best of the respective class specified teakwood, and properly seasoned, suitable for joinery work should be of natural growth, uniform in texture, straight grained, free from sapwood, dead knots, open shakes, rot, decay and any other defects and blemishes.

- 1) IS: 4021 – Timber door, window and ventilator frames
- 2) IS: 2202 - Wooden flush door shutters (solid core type) Part I
- 3) IS: 1003 - Timber 124aneled and glazed shutters (Part I & II)
- 4) IS: 4020 - Method of tests for wooden flush doors: Type tests
- 5) IS: 1761 - Transparent sheet glass for glazing and framing purposes
- 6) IS: 3097 - Specification for veneered particle boards (Exterior Grade)

B1203.1.2 At the joints the weakness of pieces must be minimum as far as possible. To place each abutting surface in a joint as neatly as possible, perpendicular to pressure. To form and fit accurately every pair of surfaces that come in contact. All joining shall be wrought on all faces and finished off by hand with sand paper with slightly rounded arises. The joints shall be pinned with hard wood pins and put together with white lead. Jointing shall be by means of mitred joints as approved. For internal joints where there is no chance of moisture the joint shall be glued. **Driving of screws with hammer is prohibited.**

B1203.1.3 The screws shall be soaked in oil before driving them home. The heads of the screws and nails shall be sunk and puttied. Any joinery work which shall split, fracture, shrink or show flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship, shall be removed and replaced with sound materials at the contractor's expense.

B1203.1.4 Door frames shall be rebated. All dimensions shall be as per drawings. The verticals of door frames shall project about 50 mm below finished floor, surface coming in contact with brick work shall be painted as directed by the Employer. The door frame shall be provided with decorative architraves and door anchors/dash fasteners as per manufactures specification. The frame shall flush with the plastered surface. The work shall conform to IS: 4021.

B1203.1.5 The workmanship of all doors and window shutters shall conform to the requirements of IS:1003 (Parts I & II) and IS: 2202 (Part I). Flush door panels shall be got tested as per IS: 4020 in standard Laboratories. Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 (Part I). Nominal thickness of shutters may be 25, 30, 35 or 38 mm.

B1203.1.6 Thickness and type of shutters shall be as specified. Width and height of the shutters shall be as shown in the drawings or as indicated by the Employer. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS 1708

B1203.2 **Core**

B1203.2.1 The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles. End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only, but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lipping.

B1203.3 **Face Panel**

B1203.3.1 The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0mm decorative veneers, provided that the combined thickness of both is not less than 2.2 mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

B1203.4 Lipping

B1203.4.1 Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth Joints shall not be permitted in the lipping.

B1203.5 Rebating

B1203.5.1 In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided.

B1203.6 Opening for Glazing

B1203.6.1 Opening for glazing shall be provided where specified or shown in the drawing.

B1203.7 Tolerance

B1203.7.1 Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be ± 1.2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

B1203.8 Adhesive

B1203.8.1 Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

B1203.9 Tests

B1203.9.1 Samples of flush door shutters shall be subjected to the following tests:

- (a) End Immersion Test
- (b) Knife Test
- (c) Glue Adhesion Test

B1203.9.2 One end of each sample shutter shall be tested for End Immersion Test. Two specimens of 150 x 150 mm size shall be cut from the two corners at the other end of each sample shutter for carrying out Glue Adhesion Test. Knife Test shall be done on the remaining portion of each sample shutter.

B1203.10 Sample Size

B1203.10.1 Shutters of decorative and non-decorative type from each manufacturer, irrespective of their thickness, shall be grouped separately and each group shall constitute a lot. The number of shutters (sample size) to be selected at random from each lot for testing If the total number of shutters of each type in a work (and not the lot) is less than twenty five, testing may be done at the discretion of the Employer and in such cases extra payment shall be made for the sample shutter provided the sample does not fail in any of the test specified.

B1203.11 Fixing of Shutters

B1203.11.1 Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly countersunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in.

B1204 FITTINGS AND FIXTURES

B1204.1 Scope of Work

B1204.1.1 The work covered under these specifications consist of supplying different types of fittings and fixtures required for doors, windows, ventilators etc. The supply shall be in accordance with the specification, drawings / approved samples. Samples of various fittings and fixtures proposed to be incorporated in the work shall be submitted by the contractor for approval of the Employer before order for bulk supply is placed.

B1204.2 General

B1204.2.1 All fittings and fixtures shall be of heavy type conforming to relevant IS code and made SS or approved materials as specified. These shall be well made reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be counter sunk to suit the heads of the specified screws. All riveted heads pertaining to hinge pins shall be well formed. Screws supplied for fittings shall be of the same metal and finish as the fittings. Samples of each fixture/ fitting shall be furnished by the contractor for approval of the Employer. Order for procurement of fittings and fixtures in bulk shall be placed only after approval by the Employer.

B1204.2.2 The fittings and fixtures to be incorporated in the work shall be strictly according to the approved sample. Fittings shall be fixed in proper position as shown in the drawing and as directed by the Employer. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with a screwdriver and not hammered in. Recess shall be cut to the exact size and depth for the counter sinking of hinges. The fittings and fixtures shall be fixed in a workmanlike manner and any damages done either to fittings and fixtures or to the shutter frames etc. should be rectified by the contractor at his own cost.

B1204.2.3 Fittings shall be of Stainless steel or as specified. The fittings shall be well made, smooth, and free from sharp edges and corners, flaws and other defects. Stainless steel fittings shall be non-magnetic, rust & moisture proof, strong & sturdy. Pin of hinges shall also be of stainless steel.

B1205 FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES

B1205.1 General

B1205.1.1 Door Frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up or resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms. /m² and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophthalic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isophthalic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat. FRP door shall be manufactured as per specifications laid down in IS14856, nomenclature of items & direction of Employer.

B1205.2 Tolerance: Tolerance of size of frame to be + 2 mm and on size of rebate to be + 1 mm.

B1205.3 Finish: The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Employer.

B1205.4 Fixing of Frames

B1205.4.1 The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the center. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

B1206 FIBRE GLASS REINFORCED PLASTIC (F.R.P.) SHUTTERS

B1206.1 General

B1206.1.1 F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and 30 mm thick Fiberglass Reinforced Plastic (F.R.P.) flush door shutter in different plain and wood finish made with fire retardant grade unsaturated polyester resin, moulded to 3 mm thick FRP laminate all around, with suitable wooden blocks inside at required places for fixing of fittings and polyurethane foam (PUF)/Polystyrene foam to be used as filler material throughout the hollow panel, casted monolithically with testing parameters of F.R.P. laminate conforming to table - 3 of IS: 14856, complete as per direction of Employer. Blocks of any seasoned hardwood of bulk density not less than 450 kg./m³ at 12 percent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the employer. One at the center and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

B1206.2 Location of Fittings and Accessories

B1206.2.1 The lock rail of door shutters shall be so placed that its center line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the employer, of the type specified. These locations shall be, one at center and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be best stainless steel or aluminum.

B1206.3 Sampling & Criteria for Conformity

B1206.3.1 The test specimens shall not have been exposed to a temperature below 40°C for 24 hours immediately preceding the test and shall be free from all visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded. If any test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

B1206.4 Sampling

B1206.4.1 Sampling criteria for conformity shall be in accordance with IS 4020 (Part-I) Lot in any consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to form a lot. The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Table below.

B1206.5 Tests

B1206.5.1 The door shutters shall be subjected to the following tests in accordance with IS 4020 (Part 1 to 16)

B1206.6 Fixing of Shutter

B1206.6.1 Door shutter shall be side hung on three bolt hinges of size 100 mm, one at the center and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel

B1206.7 Tolerance

B1206.7.1 The tolerance on the width and the height of the door shall be + 5 mm and the tolerance on the nominal thickness of the door shall be + 2 mm.

B1207 FIRE RATED DOORS

B1207.1 Door frame

B1207.1.1 Providing and fixing fire resistant door frame of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m²) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96Kg/m³. The frame will have a provision of G.I. Anchor fasteners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter. The frame shall be finished with an approved fire resistant primer or Powder coating of not less than 30 microns in desired shade as per the directions of Employer - in-charge.

B1207.2 Door shutter

B1207.2.1 Providing and fixing 60 mm thick glazed fire resistant door shutters of 120 min Fire Rating confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by Employer, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m²) duly filled mineral wool insulation having density min 96 kg/m³ and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc. all complete as per direction of Employer

B1207.3 Finish

B1207.3.1 Door frame and shutters to be primed in the stoving grade epoxy zinc phosphate primer and finished in Aliphatic grade UV resistant polyurethane paint.

B1207.3.2 Providing and fixing glazing in fire resistant door shutters, fixed panels & partitions etc., with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m²) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c , including applying a coat of approved fire resistant primer/powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc. complete in all respect as per direction of Employer. The glass shall be clear, toughened, interlayered, non-wired fire resistant having 11 mm thickness of approved brand with 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 15 min of insulation (EI15) and having a sound reduction of 37dB and LT of 86%. Glass shall be compliant to class 2B2 category of Impact Resistance as per EN 12600. The glass should be manufactured in UL & TUV audited Facility and including UL-EU Certification. The maximum glazing size cannot be more than 1100 mm x 2200 mm (w x h) or 2.42 sq. mts in total area. The test report for the complete system (Glazed Door or Partition) will be considered valid only if it contains the stamp and signature of the authorized signatory from the glass manufacturer.

B1208 MANHOLE COVERS & FRAMES

B1208.1 Manhole Covers

B1208.1.1 The heavy duty covers and frames shall conform to IS 1726 for cast Iron and IS 12592 for pre-cast concrete Covers

B1208.2 Cast Iron Manhole Covers and Frames

- (i) Manhole covers and frame shall be manufactured from appropriate grade of grey cast iron not inferior than FG150 grade of IS 210.
- (ii) They shall be cleanly cast and shall be free from air and sand holes, cold shuts and warping.
- (iii) Covers shall have on its operative top a raised chequered design to provide for an adequate no slip grip. The rise of chequers shall be not less than 4mm.
- (iv) Key holes, keys and lifting devices shall be provided in the manhole covered to facilitate their placement in the frames and their operative maintenance.
- (v) Manhole covers and frames shall be coated with materials having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.
- (vi) Size and shape and performance requirement of manhole covers and frames shall conform to IS 1726.
- (vii) Each manhole covers and frame shall have cast on them the following information:

- (a) Manufacturer's name or trade-mark
 - (b) Grade designation
 - (c) Date of manufacturer
 - (d) The words SWD or 'Sewer' to denote 'storm water drains' or 'sewer' respectively
- (viii) Identification marks as required by Employer.
 - (ix) The cover shall be gas tight and water tight.
 - (x) The sizes of covers specified shall be taken as the clear internal dimensions of the frame.
 - (xi) The approximate weight of the various type of manhole covers and frames shall be as per IS 1726.
 - (xii) The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

B1208.3 Pre-Cast Concrete Covers & Frames

B1208.3.1 Pre-cast reinforced cement concrete manhole covers intended for use in sewerage and water works shall generally conform to IS 12592.

B1208.4 Materials

Cement: Cement used for the manufacture of pre-cast concrete manhole covers shall be 53grade Portland cement conforming to IS-12269.

Aggregates: The aggregates used shall be clean and free from deleterious matter and shall conform to the requirements of IS-383. The aggregates shall be well graded and the nominal maximum size of coarse aggregate shall not exceed 20 mm.

Concrete: The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing etc. The minimum cement content in the concrete shall be 330 kg/m³ with a maximum water cement ratio of 0.45. Concrete weaker than grade M-25 (design mix) shall not be used. Compaction of concrete shall be done by machine vibration.

B1208.5 Reinforcement

- (a) The reinforcement steel shall conform to IS 1786. Reinforcement shall be clean and free from loose mill scale, loose rust, and mud, oil, grease or any other coating which may reduce or destroy the bond between the concrete and steel. A light film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.
- (b) Fiber Steel: The diameter/equivalent diameter of steel fibres where used, shall not be greater than 0.75 mm. The aspect ratio shall be in the range of 50 to 80. The minimum volume of fibres shall be 0.5 percent of the volume of concrete. The reinforced concrete manhole cover, and frame shall be designed in accordance with the provisions of IS456. Clear cover to reinforcement shall not be less than 15 mm.

B1208.6 Shapes and Dimensions

B1208.6.1 Shape, dimensions and tolerance of pre-cast concrete manhole covers and frames shall conform to IS 12592. Outside dimension of cover at top shall match with corresponding frame so that the maximum clearance at top between the frame and the cover all round the periphery is not more than 5 mm and the top surface of the frame and covers, is in level within a tolerance of +5 mm. For facility of removing the cover from the frame, suitable taper matching with taper given for the frame shall be provided to the periphery of the cover.

B1208.7 Lifting Device

B1208.7.1 The minimum diameter of mild steel rod used as lifting device shall be 12 mm for light and medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by hot galvanizing or epoxy coating or any other suitable treatment.

B1208.8 Finishing & Coating

B1208.8.1 To prevent any possible damage from corrosion of steel the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish. In order to protect the edges of the covers from possible damage at the time of lifting and handling it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2.5 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anticorrosive paint or coating. To prevent the top outer edge of frame from possible damages, it shall be protected by 25 mm X 3 mm mild steel flat as part of the frame.

B1208.9 Physical Requirements

(a) General

All units shall be sound and free from cracks and other defects which interface with the proper placing of the unit or impair the strength or performance of the units. Minor chipping at the edge/surface resulting from the customary methods of handling during delivery shall not be deemed for rejecting.

(b) Load Test

The breaking load of individual units when tested in accordance with the method described in IS 12592 shall be not less than the values specified in CPWD specification.

B1208.10 Fixing

B1208.10.1 The frames of manhole shall be firmly embedded to correct alignment and level in RCC slab or plain concrete as the case may be on the top of masonry which shall be paid as extra unless specified otherwise.

B1209 PLASTERING AND POINTING

B1209.1 General

B1209.1.1 The thickness of plaster mentioned in Drawings is finished thickness exclusive of dubbing coat. Plastering & dubbing coat shall, however be done in one operation with plaster. All work under this head shall be carried out as per CPWD specifications for finishing works.

B1209.1.2 All corners, angles, junctions and edges shall be truly vertical or horizontal as the case may be and shall be carefully finished. Corners around jambs of opening and junction of walls shall be rounded to minimum radius to 5 mm. 12 mm wide groove at junction of all walls and RCC slabs to the entire thickness of wall plaster shall be provided. Also trowel grooves shall be provided at junction of walls and RCC columns or any other dissimilar material i.e. wooden/steel chowkhats etc. 25 mm Groove all around the buildings at junction of Parapet wall and floor shall be provided as per the Drawings and Specifications. 100 mm band shall be provided on all sides other than chajja side and the band shall not be extruded >50 mm and not less than <25 mm from the finished wall surface.

B1209.1.3 Contractor's attention is invited to local practices and the local availability of materials like bricks, form work etc., and cater for any extra dubbing required for touching up properly and for smooth and even surfaces. This shall be deemed to have been included in the item rate quoted for plasterwork, as applicable.

B1209.2 Materials

B1209.2.1 Cement

B1209.2.2 Cement shall be as specified in Materials under Specifications.

B1209.2.3 Sand

B1209.2.4 Sand used for plastering works shall confirm to IS 1542 (Latest Revision)

B1209.3 Workmanship

B1209.3.1 The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

B1209.4 Cement Plaster

B1209.4.1 The cement plaster shall be 12 mm, 15 mm or 18 mm thick as specified in the item.

B1209.5 Cement Plaster with a Floating Coat of Neat Cement

B1209.5.1 When the plaster has been brought to a true surface with the wooden straight edge it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sq.m. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described and shall apply.

B1209.6 6mm Cement Plaster on Cement Concrete and Reinforced Cement

B1209.7 Preparation of Surface

B1209.7.1 Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition, concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacing of not more than 5 cm. Centers, the pock being made not less than 3 mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

B1209.8 Mortars

B1209.8.1 Mortar of the specified mix using the types of sand described in the item shall be used. It shall be as specified.

B1209.9 Application

B1209.9.1 To ensure even thickness and a true surface, gauges of plaster 15 x 15 cm. shall be first applied at not more than 1.5 m intervals in both directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally, the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar. Plastering of ceiling shall not be commenced until the slab above has been finished and centering has been removed. In the case of ceiling of roof slabs, plaster shall not be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

B1209.10 Finish

B1209.10.1 The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

B1209.11 Thickness

B1209.11.1 The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5 mm.

B1209.12 Scaffolding

B1209.12.1 For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one meter in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

B1209.13 Preparation of Surface

B1209.13.1 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.

B1209.14 Mortar

B1209.14.1 The mortar of the specified mix using the type of sand described in the item shall be used. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

B1209.15 Application of Plaster

B1209.15.1 Ceiling plaster shall be completed before commencement of wall plaster. Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 x 15 cm shall be first applied, horizontally and vertically, at not more than 2meters intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally, the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troweling or over working the float shall be avoided.

B1209.15.2 All corners, arises, angles and junctions shall be truly vertical or horizontal as the case maybe and shall be carefully finished. Rounding or chamfering corners, arises, provision of grooves at junctions etc. where required shall be done without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

B1209.15.3 When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not nearer than 15 cm to any corners or arises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arises. Horizontal joints in plaster work shall not also occur on parapet top sand copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar. No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

B1209.16 Thickness

B1209.16.1 Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brickwork, the minimum thickness over any portion of the surface shall be not less than 15 mm while incase of stone work the minimum thickness over the bushings shall be not less than 12 mm.

B1209.17 Curing

B1209.17.1 Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 10 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Employer may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

B1209.18 Finish

B1209.18.1 The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

B1209.19 Precaution

B1209.19.1 Any cracks which appear in the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Employer.

- (i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm drawn with any suitable method with the wall while the plaster is green.
- (ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150 mm wide chicken wire mesh should be fixed with U nails 150 mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails payment shall be made separately.

B1210 CEMENT PRIMER COAT

B1210.1 General

B1210.1.1 Cement primer coat is used as a base coat on wall finish of cement or any other surfaces before Paints are applied on them. The cement primer is composed of medium and pigments which are resistant to the alkalis present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of Paints.

B1210.1.2 Primer coat shall be preferably applied by brushing and or by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying emulsion Paints etc.

B1210.2 Preparation of the Surface

B1210.2.1 The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sandpapering the same after it is dry.

B1210.3 Application

B1210.3.1 The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before emulsion Paint is applied.

B1210.4 Scaffolding

B1210.4.1 Scaffolding shall be got approved from Employer in advance. Scaffolding has to be in steel, arranged by the contractor at his own cost for carrying out entire painting jobs at all height and provide all facilities for proper inspection of surface at various stages. Material has to be erected as per safe methods. Ropes and guy wires shall be used for tying etc. The scaffolding shall be of steel and shall not endanger the painter. Scaffolding shall be sufficiently away from the surface to be painted so as to enable the painter to work with ease. The scaffolding shall be removed by the contractor promptly after completion of the work.

B1210.5 Protective Measures

B1210.5.1 Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be painted, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

B1211 CEMENT BASED PUTTY WORK

B1211.1 Surface Preparation

B1211.1.1 Remove all loosely adhering material from the wall surface with the help of sand paper, putty blade or wire brush. The substrate should be clean, free from dust, grease and loose materials.

B1211.2 Mixing

B1211.2.1 Mixing with 40-45% clean water slowly to make a paste. It is very important that water be added to putty to make a mix and not vice versa. Continue the mixing or 10-15 minutes till a uniform paste is formed. It is very important that the mixing of putty should be done thoroughly. This will help in easy application, obtaining more coverage and smooth uniform shade. Only prepare a quantity which can be used within 2-3 hours of mixing with water.

B1211.3 Application

B1211.3.1 After thoroughly mixing Putty apply the first coat on the moistened wall surface from bottom to upward direction uniformly with the aid of putty blade. This would ensure minimum wastage and proper finish.

B1211.3.2 After drying of first coat of putty just rub the surface gently with wet sponge or very gently with the putty blade in order to remove the loose particles. Allow the surface to dry for at least 3 hours and then apply second coat of putty. Leave the surface to dry completely. After drying of second coat remove any type of marks with the help of moist sponge or rub the surface very gently with putty blade. Leave the surface to dry, preferably overnight/10-12 hours.

B1211.3.3 Always prepare a required quantity of putty and use it within 2-3 hours of mixing with water.

B1211.3.4 The total thickness of the coats should be limited to maximum 1.5 mm. It is not necessary to rub the surface done with putty. However, if at all there is a need to remove unevenness before applying any kind of paint/distemper, gently level the surface with very fine water proof emery paper of not less than 500 number to get a glossy white surface.

B1211.4 Precautions during application

B1211.4.1 Mixing of the Putty is very important. Hence extreme care should be taken for proper and thorough mixing. It should be preferably mixed with mechanical stirrer in order to get best results. Mixing is to be continued till a uniform paste is formed. Do not add putty into water.

B1211.4.2 It is recommended not to rub the surface done with Putty strongly & harshly with rough emery paper. This breaks the film formed over it which decreases the water repellence properties. In case of fresh concrete/mortar surface it is recommended that two coats of cement wash be done before application of Putty.

B1211.5 Scaffolding

B1211.5.1 Scaffolding shall be got approved from Employer in advance. Scaffolding has to be in steel, arranged by the contractor at his own cost for carrying out entire painting jobs at all height and provide all facilities for proper inspection of surface at various stages. Material has to be erected as per safe methods. Ropes and guy wires shall be used for tying etc. The scaffolding shall be of steel and shall not endanger the painter. Scaffolding shall be sufficiently away from the surface to be painted so as to enable the painter to work with ease. The scaffolding shall be removed by the contractor promptly after completion of the work.

B1211.6 Protective Measures

B1211.6.1 Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be painted, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

B1212 PAINTING WORKS

B1212.1 Materials

B1212.1.1 Paints of approved brand and manufacture shall be used. Only ready mixed Paint as received from the manufacturer without any admixture shall be used. If for any reason, thinning is necessary in case of ready mixed Paint, the brand of thinner recommended by the manufacturer or as instructed by the Employer shall be used.

B1212.1.2 Approved Paints shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Employer. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Employer.

B1212.2 Commencing Work

B1212.2.1 Painting shall not be started until the Employer has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

B1212.2.2 Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

B1212.3 Preparation of Surface

B1212.3.1 The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Employer after inspection, before painting is commenced.

B1212.4 Application

B1212.4.1 Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also; the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

B1212.4.2 The paint shall be applied with a brush/roller/spray on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush/roller/spray marks.

B1212.4.3 The contractor shall arrange a quality inspection by the manufactures of the paint for ascertaining the quality of the painting application.

B1212.5 Protective Measures

B1212.5.1 Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be painted, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

B1213 ACRYLIC EMULSION

B1213.1 Materials

The Acrylic Emulsion paint of approved premium quality shall be used for both exterior and interiors.

B1213.2 Application

- B1213.2.1 The surface preparation shall be as described above. The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.
- B1213.2.2 The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions
- B1213.2.3 The surface on finishing shall present a flat velvety smooth finish. If necessary, more coats will be applied till the surface presents a uniform appearance and finally accepted by the Employer.

B1214 CEMENT BASE PAINT

B1214.1 Materials

- B1214.1.1 The material shall be complying to IS 5410 (Latest Revision) Application. For New Work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement paint shall be applied over patches after wetting them thoroughly. The base paint shall be of approved make and base paint shall be procured from the same manufacturer, who will supply acrylic emulsion paint.

B1214.2 Application

- B1214.2.1 Cement paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously
- B1214.2.2 The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work

B1214.2.3 The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted. For new work, the surface shall be treated with three or more coats of water proof cement paint as found necessary to get a uniform shade.

B1214.2.4 Water proof cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, paints etc. It shall not be applied on gypsums, wood and metal surfaces.

B1215 PLASTER OF PARIS PUNNING WORK

B1215.1.1 Wherever required, POP work shall be provided by the contractor from the reputed manufacturers approved by the Employer. If the plaster surface is to be finished with plaster of Paris punning, the surface shall be combed slightly with the wire brushes or nails before it is completely set to form key for plaster of Paris punning. The surface shall be thoroughly cleaned of dust then only damped but not soaked before the application of plaster of paris punning. The Gypsum for preparing punning shall be approved quality. It shall be dry and free from lumps and shall be suitably packed in watertight bags or containers. Paste shall be prepared by adding required quantum of water and same shall be used before it sets. No dropping paste shall be used in the work. Punning shall be applied to the prepared surface with steel trowel to a thickness required to make the surface produce perfectly smooth and even surface working from top to bottom. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water, and then sand papering the same after it is dry. Filling in plaster shall be made good with plaster of paris mixed with colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. The surface shall be allowed to dry thoroughly before the regular coat of paint is applied.

B1216 CLAY TILE CLADDING

B1216.1 General

B1216.1.1 Providing and fixing Clay tile (300x600mm) cladding existing framework which have a headrabbet on the upper rear edge and a drip rabbet on the lower front edge. The thickness of the tiles is approx. 20 mm which are individually fixed on the substructure with holders made from the Aluminium alloy AlMgSi 0.5 F25. The horizontal joint has a width of 12mm and a depth of approx. 20mm. With a clip-like fixture, these are arranged on a special horizontal aluminium profile, which is resistant to salt water. Clay tiles decorate façades all over the world. The basis of the system is clay tiles that are fired at very high temperatures in a specially developed process. This ensures that every individual tile corresponds to the highest standards of weather resistance and long life. A high-tech calibrating installation guarantees that the clay tiles are produced in an extremely precise format, which is essential for a perfect and noticeable joint play. The key advantages are:

- Unique Ventilated façade system- Due to which temperature can be dropped inside the Structure
- Innovative & high-tech calibrating installation design- Can differentiate the wall from the tile & insulate the wall from rain & outside temperature.
- Clay facade blends with contemporary architectural materials- Can match with Glass Façade or ACP for different Architectural look.
- Weather resistance – Completely seals the Wall from Rain & have a drainage system to make rain water pass through.
- Long life –Since it is a homogeneous material, no chance for any colour wear & tear.
- Dimensionally stable- Since it is heated around 1200 degrees, there is no variation in the tile dimensions due to temperature variations.
- Maintenance free- Can clear dust on it with rain & air.

B1216.2 **Technical Description**

B1216.2.1 The applicability of façade systems is regulated in various country-specific technical approvals. Specific requirements are:

B1216.2.2 Calculation of specific mass or density is performed in accordance with EN 10545-3. The tiles meet the requirements for frost resistance according to EN 1304. In addition, tests according to EN 10545 are carried out regularly in the course of internal and external monitoring, e.g. to determine:

- The mass, evenness and surface qualities
- Thermal shock resistance
- Water absorption
- Thermal expansion
- The bending strength & breaking load
- Moisture expansion
- Impact resistance
- Chemical resistance
- Resistance to staining

B1216.3 **Substructure and Insulation**

B1216.3.1 For the vertical basic substructure aluminium wall brackets are anchored in statically required intervals on the building wall. Afterwards, thermal insulation is applied to the previously cleaned surface of the wall. The choice of insulation material in each individual case depends on the property and its particular requirements. The T-profiles are aligned with the consoles and fastened with approved fasteners such as rivets or screws.

B1216.4 Horizontal Substructure

B1216.4.1 The substructure consists of vertical L-profiles anchored to the building with wall brackets. Horizontal aluminium rails are installed on the basic substructure. The distance depends on the height of the tiles which are fastened to the horizontal rails with aluminium clamps. Joint profiles are arranged in the vertical joints. This prevents lateral movement of the façade tiles and makes sure that the tiles sit securely in the clamps. In addition, water is prevented from penetrating the vertical joints.

B1217 LOUVERS

B1217.1 General

B1217.1.1 132S type aluminum louvers consisting of panels manufactured from 0.6 mm thick aluminum alloy AA3005/3105, of height 132mm and 98.5 mm wide, supplied to required lengths up to a maximum of 6 mtrs, to be installed at a panel module of 100mm by means of aluminum brackets. The brackets belonging to the system, 20-25 mm wide, made of extruded aluminum, black anodized to 20 microns shall be fixed to the sub structure at a centre to centre of 150 mm as required and panels clipped on. Clamps shall be fixed at 150mm from panel edges and maximum center-to-center spacing of 1000mm all properties and specifications shall comply with ECCA directives and more specifically EN 1396:1996.

B1217.2 Paint Finish

B1217.2.1 Panel shall be stove enamelled and finished with Luxacote, a patented special three layered coating system (consisting of first a conversion layer of thickness 800-2000mg/sq mtr, a polyurethane basecoat of 16-20 microns, and a special top coat of polyamide particles of 812 microns thick to provide excellent abrasion and damage resistance) in a continuous coil coating process of the approved colour on the exposed side and the reverse side with epoxy

B1217.3 Technical Data

- Shape: height 132mm and 98.5 mm wide
- Panel section: Slotted Fastening Profile, Mullion Profile Grooved, module 125 mm
- Brackets: The brackets belonging to the system, 20 - 25 mm wide, made of extruded aluminium, black anodized to 20 microns shall be fixed to the sub structure
- Sub structure: sub structure at a centre to centre of 150 mm as required and panels clipped on. Clamps shall be fixed at 150 mm from panel edges and maximum centre-to-centre spacing of 1000mm
- Surface treatment: Panel shall be stove enamelled and finished with Luxacote, a patented special three-layered coating system (consisting of first a conversion layer of thickness 800-2000mg/sq.mtr, a polyurethane basecoat of 16-20 microns, and a special top coat of polyamide particles of 812.

- Installation: Panels are mounted on the Slotted Fastening Profile by means of Locking Clips and Pop Rivet and the whole system is mounted on the MS Sub-structure by means of Square Brackets

B1218 WATER STOPS

B1218.1.1 Water stops shall be of approved make provided locations indicated on drawings. Waterstops shall be but jointed but heat welding to obtain continuity it shall be cleaned thoroughly of all concrete and mortar coating as directed before resuming concrete work. Water stops shall be in long lengths to avoid joints as for as possible.

B1219 METHYL METHACRYLATE COATING

B1219.1 General

B1219.1.1 Providing and applying 5mm (max)Self levelling system is a fast curing, decorative, hard wearing, methyl methacrylate coating (MMA flooring) in 3 layers. Coloured Quartz is enclosed in the system to achieve the required slip resistance for the specific industry

- All chemicals used for the floor coating, are of environmentally friendly and cured within 2-hour time, means you can use the floor 2 hours after application of final coating. Coatings are, anti-skid, no joints, non-static, zero porosity, highly flexible, easy to clean, fast curing, easy to repair, food safety certified by HACCP based food safety program and have very long life.

B1219.2 Floor Hardness.

- Compressive Strength of 3 – 6 mm thickness is 45 N/mm².
- Tensile strength in binding of 3 – 6 mm thickness is 25 N /mm².

B1219.3 Application

B1219.3.1 This coating to the floor, only when the moisture level is below 4 %. We dry grind the surface to create a new face of the floor and vacuum it thoroughly, make sure no loose dirt on the surface. Then we apply the primer coat, after drying, then we apply the Scratch coat to cover any gaps or dents if present, then the main coat followed by top coat. The recommended substrate is M25 concrete and must be in good level finish for best results since the product is gravity leveling. If the surface has tiles, it is to ensure that the tiles are well set and the tiles will not come off once the product is laid.

Physical Properties	Strong, Flexible, Flexible years, highly durable
Laying floor condition	Levelled and Surface humidity less than 4%
Fire Hazard classification	Fire Retardant
Application areas	high human and vehicle traffic, outdoors and indoors, Slip resistant walk ways, designs on floors, Jetty areas, Floor Markings, Staircases, Approach ramps, Walk in chillers and coolers, bathrooms, etc

Surface Finish after laying	Smooth mirror like, Medium friction anti slip, Very high friction
Surface Finish textures	Sand finish, Flakes Finish, Mirror Finish
Colour Options	Various coloured Quartz and flakes available, please refer attachment
Curing period	90 Minutes after application of top layer
Substrate recommendation	M25 concrete

B1220 PUF PANELLED ROOFING

B1220.1 General

B1220.1.1 Supply and fixing of PUF Panel roof in 50mm thick made out of 0.50mm TCT colour coated aluminium sheets of approved colour

B1220.2 Profile

B1220.2.1 34.5mm crest height in 333.3mm pitch on the top and 0.50mm TCT colour coated aluminium slightly ribbed sheet at the bottom with Polyurethane Foam insulation as infill.

B1220.3 Colour

B1220.3.1 The colour coating on sheet shall have a total coating thickness of 35 micron comprising of 20 micron Silicon Modified Polyester Paint system of approved colour on the top and 5 microns back up epoxy coating at the bottom over 5 micron primer coating on both sides.

B1220.4 Infill

B1220.4.1 The infill insulation material (PUF) shall be fire retardant self-extinguishing CFC/HCFC Free and Zero ODP (Ozone Depletion Potential). Polyurethane Foam shall have a density of $40 + 2\text{Kg/M}^3$ in 50mm thick (50 mm + 34.5mm at crest) injected in between the top & bottom sheet using a special foaming machine. The supply width of panel shall be 1080mm (1mtr effective width) and length to be as per the site requirement up to a maximum of 12mtr. The panel shall be manufactured from a continuous panel manufacturing line using pentane as blowing agent. The panel to be directly fixed to the purlins with galvanized imported self-drilling and self-tapping fasteners with EPDM washers. All the joints should be sealed with sealants and stitched with stitching screws wherever necessary.

B1221 PVC MEMBRANE WATER PROOFING IN BASESLAB & SIDE WALL

B1221.1 Scope of Work

B1221.1.1 The structure requires a watertight system from retaining wall, construction joints, basement floor, roof garden etc. Requirement of a loose laid passive membrane to allow the movement in the substructure over time. The membrane should be able to be tested and inspected before the concreting is commenced. The structure needed to be compartmentalized to restrict the spread of leakages. The leakages need a curative system in place which would assist speedy rectification with the minimum disruption. Need for reliable longlasting watertight system. In case of any leakage in future, to arrest the leakage provision for doing injection grouting shall be created during the waterproofing stage to avoid any puncturing of the basement floor for the treatment.

B1221.2 Waterproofing System Solution:

B1221.3 Single ply PVC membrane waterproofing system

B1221.3.1 Specified thickness in all areas, with special treatment for the pile head / roof garden areas and pressure release pipes. The Geotextile membranes provide the slip resistance between the substrate and the membrane in all areas, with an additional layer on top of the membrane in the vertical areas as protection. The capability of welding the PVC surface water stops to the waterproofing membrane provides the capability of compartmentalizing the structure and treating the joints in the raft and the retaining wall to make them watertight.

B1221.4 Application Procedure on Horizontal Surface over PCC

B1221.5 Surface Preparation

B1221.5.1 The substrate shall be PCC concrete of sufficient thickness to ensure a firm substrate that will not crack or deform under normal trafficable conditions during waterproofing installation, and structural concreting operations. It should be smooth, free from debris and other irregularities, which may puncture and damage the waterproof liner.

B1221.6 1st Layer – Adjustment layer over PCC

B1221.6.1 All horizontal surfaces should be covered with a uniform adjustment layer using Non-Woven Geotextile. It has the purpose of ensuring the uniformity of the substructure in order to avoid that faults, irremovable debris or other roughness in the underlying layer may cause damage, perforate or punch, the waterproof layer.

B1221.6.2 The uniformity layer should be geotextile Non-Woven resistant to micro-organisms, needle-punched 100% pure polypropylene yarns, with a weight minimum of 300 gsm. The geotextile layer shall be laid on the substrate ensuring no gaps in the geotextile. The geotextile should be checked prior to the application of the waterproofing membrane.

B1221.7 2nd Waterproofing Membrane Layer

B1221.7.1 The watertight element on all horizontal surfaces shall be 2/1.5mm thick. This is a synthetic membrane made of plasticized PVC manufactured by twin coloured (having signal layer) co-extrusion method.

B1221.8 Horizontal Installation

B1221.8.1 Prior to installation of the membrane, the surface shall again be checked for sharp objects that may damage the membrane and uniformity layer is properly in place. Roll out the membranes with an minimum overlap of 80 mm. The membrane is loosely laid on the horizontal surface. The edges of the membranes to be welded must be clean and dry. Use a clean scrubber and water to remove the dust deposits and impurities.

B1221.8.2 Sample weld to test the temperature should be carried out before starting the work and the sample weld should be subjected to the destructive testing as per instructions. Depending on the environmental condition on the building site, the welding temperature shall be in the range of 450-550° Celsius.

B1221.8.3 Overlap of membrane shall be minimum 80mm and the double seam welding is done. A pocket is created throughout the length of the membrane. Both the ends of the membrane are plugged and using pressure testing machine air pressure of 2 bars is applied. Introduce pressurized air by means of a foot pump at approximately 2 bar, wait for 1 minute to ensure the complete expansion of the inside groove and then start the actual testing taking the pressure back for 2 bar. After a 10 minute interval again check the air pressure. A 20% pressure decrease (due membrane expanding and lose from the attached testing equipment is acceptable.) It ensures the air tight joint, which is in turn watertight.

B1221.9 Compartmentalization

B1221.9.1 Water stops shall be placed at all construction joints and strategic locations to be determined at site so as to have compartments of at least 150m². The waterproofing membrane shall be welded to the PVC water stops to ensure it becomes an integral part of the waterproofing system. The purpose of the PVC water stop is to prevent, in the case of leakage, water passing from one side of the construction joint to the other, thus limiting the remedial works required after completion, should leakage occur.

B1221.10 3rd Layer of Geo Textile as Protection Layer

B1221.10.1 The PVC membrane shall be covered with a uniformity layer using Non - Woven Geotextile resistant to micro- organisms, needle-punched 100% pure polypropylene yarns, with a weight of 300 gsm. The Geotextile layer shall be laid over the PVC Membrane ensuring no gaps in the Geotextile. The geotextile should be checked prior to laying of protection screed.

B1221.11 Protection Layer

B1221.11.1 A 50mm layer of protection PCC shall be laid on top of the geo textile layer following welding and checking of blue signal layer to ensure no damage occurs to the membrane during installation of structural reinforcement and structural concreting. Any damage to the blue signal layer shall be recorded and the necessary patch repairs conducted before casting of the protection layer.

B1221.12 Treatment of the Pile Cap

1. The membrane is dressed up to the outer surface of the rebar. This membrane is then encapsulated, which is an epoxy grout.
2. The grout has a minimum thickness of 10mm below the membrane and 20mm on top of it. The grout is extended to the edge of the pile.
3. When the dewatering is switched off or when movement takes place due to settlement or loading, the membrane is allowed to move with the structure (because it is laid loose) yet held in place at the pile top with the epoxy.
4. This epoxy also forms a barrier at the top of the pile to stop water rising through capillary action in the matrix of the pile concrete.
5. Pile cap waterproofing: The epoxy grout is used to cap the pile heads and sandwich the membrane, while allowing a movement capability at the interface of the pile head and the structure and to waterproof the pile cap. Reprofile and repair the pile heads prior to the watertight system being installed if required.

B1221.13 Treatment for Retaining Wall

B1221.14 Surface Preparation

B1221.14.1 The concrete surface should be smooth without any honeycomb or surface irregularities. Any honeycomb should be repaired with suitable repair mortar.

B1221.15 Compartmentalization

B1221.15.1 Rear Guard water stopper shall be fixed to the shutter at predetermined locations before fixing it for concreting. After the removal of the shutter the back of the water stopper shall be cleaned to remove any slurry and dirt before the application of the membrane.

B1221.16 1st Layer of Geotextile

B1221.16.1 All the vertical surfaces of the retaining wall should be covered with a uniformity layer using Non-Woven Geotextile. It has the purpose of ensuring the uniformity of the substructure in order to avoid that faults, irremovable debris or other roughness in the underlying layer may damage or puncture, the waterproof layer.

B1221.16.2 The Geotextile shall be resistant to micro-organisms, needle-punched 100% pure polypropylene yarns, with a weight of 300 gsm. The geotextile should be checked prior to the application of the waterproofing membrane.

B1221.17 2nd Vertical Installation of the Membrane

- i. Membrane on vertical surfaces shall be fixed by means of roundel fixings as per approved manufacturer specification & Technical manual.
- ii. The Roundels shall be of PVC material, and are an essential part of the waterproofing system. The PVC Roundel besides keeping the sheet adhered to the substrate is also a safety element in case of irregular tensioning of the membrane. The PVC Roundel is designed with a pre-established breaking load and will yield before any damage occurs to the lining.
- iii. The membrane is laid from top to bottom and welded together using a double hot wedge automatic welder. Overlap of membrane shall be minimum 80 mm and the double seam weld shall allow for checking of water-tightness.
- iv. Welding is carried out using a hot wedge automatic welding machine.
- v. To guarantee the integrity of the weld, a pneumatic test is applied to ensure no pressure loss in the air spaces between the seam weld and is recorded on inspection sheets.
- vi. Successive sheets of Geotextile shall be laid to ensure no gaps between the sheets and act as slip layer to accept the waterproofing membrane and ensure no puncturing of the membrane.
- vii. A competent person shall inspect the rondel, geotextile and membrane application at each stage, similarly to horizontal membrane to ensure that no damage has occurred.
- viii. Any defects identified shall be rectified immediately repaired and re-inspected

B1221.18 3rd Layer of Geotextile

B1221.18.1 All the vertical surfaces of the retaining wall where membrane is installed shall be covered with a uniformity layer using Non-Woven Geotextile, which shall be resistant to micro- organisms, needle-punched 100% pure polypropylene yarns, with a weight of 300 gsm. The geotextile should be checked prior to the application of the waterproofing membrane.

B1221.19 Protection Boards

B1221.19.1 To protect the (PVC membrane) from getting damaged due to back filling, **15mm thick E-por boards** are to be erected vertically in panels throughout the vertical length of the retaining wall and then the back-filling work is carried out or use of 500gsm of geotextile as protection Layer. Type of Protection layer to be used can be decided based on-site condition and the type of back fill material to be used.

B1221.20 Built - Up for Retaining Wall

- i. **Separation Layer:** 300 GSM Geotextile layer to be laid over the Retaining Wall
- ii. **Roundels:** Fixed on the Vertical Wall, used to hold the Membrane on vertical position at time of installation.
- iii. **Waterproofing Layer:** PVC Waterproof Membrane (2mm thick) is a synthetic waterproofing membrane made of plasticized PVC manufactured by twin coloured co-extrusion method.
- iv. **Protection Layer:** Laying of 15mm thick E-por protection Boards over the PVC Membrane to ensure that the PVC membrane is not damaged due to back filling or geotextile or other protection based on site condition and type of back fill material

B1221.21 Treatment Using Re-Injectable Hose

B1221.21.1 Construction joints at the retaining wall shall be installed with Re-injectable hose. Re-injectable hose specially designed with circular cross-section and containing neoprene seals on the openings which ensures one way flow of injection resin from inside out. The hose must be designed to demonstrate re-injection capabilities at site. The Manufacturer shall provide all accessories required for end terminations and vacuuming arrangements for maintaining re-injection capabilities. Re-injectable hose shall be injected with hydro-swelling vinyl ester metha-acrylate based resin only to maintain the re-injectability property of the hose.

B1221.21.2 Re-injectable hose shall be injected with, hydro swelling, water based, low-viscous, thermo-setting resin based on vinyl metha-acrylate chemistry. The Injection resin shall have re-swelling capacity up to 2.5 times by volume in potable water. The injection resin shall contain accelerator to regulate the setting times and shall not of expanding foam type product or non-swelling formulation. The injection resin shall be effective in saline water by exhibiting positive expansion.

B1221.22 Re-injectable hose system Application

1. The re-injectable hose should be prefabricated to suit the actual installation in a particular construction joint.
2. The hose should be installed just prior to formwork being done for further concrete works. The surface of the concrete where the hose is installed should be flat and smooth. In case surface retarders are used on the concrete joints, the length where the hose is to be installed should be kept free of retarder for a width of 40-50 mm.
3. The hose is generally installed in lengths of 10-12 meters max and in rare situations or trafficked joints it can be extended by a few meters. This length restriction is governed by the injection efficiency. Wherever possible, terminate the hoses in a vertical element of the structure or at the edge of the horizontal casting.

4. Fabricate hose in lengths of max. 12m depending on the structure. Attach approximately 400mm lengths of vent hose to both ends of hose and cover the junctions with a heat shrinkable plastic sleeve. The vent serves as an injection (or exit) port and hence does not have discharge holes. The different colours (green and clear) of the vent hoses are to identify the input and exhaust ends.
5. The vent hoses at the two ends of the hose should be of two different colours, to indicate of the end of one end of a hose and the start of the other in the box.
6. The termination boxes can be procured locally. Normal electrical boxes can be cast into the concrete. The size of the box may vary according to the number of hoses terminating in the box. Generally, this number should not exceed 4 to simplify the injection works, when required. There should be approx. 20 cm of vent hose projecting out of the concrete.
7. Prior to formwork being placed, a visual inspection of the hose should be carried out. Any hose found displaced should be fixed firmly and any hose found damaged should be replaced.
8. The location of the hose in a particular joint depends on the thickness of the concrete element but as a guideline it should be in the centre of an element up to 800mm thick. For concrete elements greater than 800mm thick, the hose should be installed within 500mm from the face where water ingress is expected.
9. The vent hose may be tied to the reinforcement for support. Use tie wires, taking care that the binding is not too tight. The hose should be fixed to the concrete using the clips supplied at a distance not exceeding 20cm. More clips may be required at turns and verticals. The hose should rest flat and be firm against the substrate so as not to be displaced by concrete being poured. There should be no gaps under the main hose where concrete or slurry might form another joint or displace the hose.
10. End caps should be installed at the vent ends during fabrication and should not be removed until injection has to be carried out. This will ensure that debris will not enter the hose during construction and during the life of the building.

B1221.23 Treatment for Construction Joints

B1221.24 Treatment using Hydro swelling gasket

- B1221.24.1** Construction joints at the retaining wall shall be installed with 10mm x 10mm cross-sectional sized hydro-swelling water bar based on advance vinyl acrylate polymers. The water bar shall be formulated to exhibit low pre-mature swelling (less than 50% within 12 hours) and shall not be based on super absorbents. The water bar shall have low swelling pressure; not exceeding 0.25 MPa at full swelling capacity. The water bar shall be installed with special adhesive.

B1221.25 Installation in Construction Joints

B1221.25.1 Hydrophilic acrylate-based water bar shall be placed in all construction joints as secondary protection to PVC membrane system. The concrete substrate to which the water bar is to be fixed must be smooth and sound. Cut the water bar to the required length. Fix the water bar to the concrete substrate using Adhesive. Apply light tension to the water bar as it is being fixed. Allow the adhesive on the verticals to dry at least over night before concreting. Protect the fixed water bar from mould release oil and dirt. Do not saturate the water bar before concreting as this may cause it to swell. After placement of the water bar, cast the next concrete pour.

B1221.26 Quality Control / Assurance

- (a) The waterproofing work should be carried out by approved applicator & should be inspected and tested in accordance with quality check and inspection test report of the Manufacturer. This report will be used to verify compliance of the waterproofing work. Applicator & Manufacturer should together give 10-year warranty for the waterproofing.
- (b) Training workshop to be conducted by approved authority at site or at clients place for the client's QA/QC/Employer/supervisor on welding/testing of weld joints and on supervision of entire membrane installation.
- (c) After each welding sequence, the weld shall be tested using air pressure upto 2 bars initially. After attaining a pressure of 2 bar, the pressure usually settles to something between 1.6 and 2 bar. The pressure drop is because the material is elastic and relaxes around the needle insert location allowing some air to escape. This does not mean the weld has failed. The weld has failed when no pressure can be maintained, and the pressure gauge drops immediately back to zero. A successful weld is where the pressure has been maintained in this range for 5 to 10 minutes and the air channel has fully inflated. Each successful weld shall be signed and dated by site supervising Employer and documented as per manufacturer's specification.
- (d) The results shall be recorded on the relevant quality check and inspection test report and signed jointly by Employer as well as applicators site supervising Employer.
- (e) Testing of every seam welded joint length shall be pressure tested and recorded the tested data shall be written adjacent to every welded joint length on the installed membrane itself.
- (f) The surface of membrane shall be visually inspected to ensure that no black areas are present. Wherever such areas are noticed, a patch shall be placed in this location.

B1222 WATER SUPPLY, SANITARY & PLUMBING

B1222.1 Materials

- Ductile Iron Pressure Pipes and Fittings
- CPVC Pipes for Potable Water
- HDPE Pipes for Soil Waste & Drainage Purpose
- RCC Pipes
- Water Storage Tanks

B1222.1.1 Storage capacity of tanks shall be all as mentioned in Drawings. Water storage tank shall be of rotational moulded, HDPE, ISI marked triple layered manufactured from virgin plastic and FDA approved and as per the relevant IS.

B1222.2 Workmanship

B1222.2.1 Refer relevant IS

B1222.3 Testing

B1222.3.1 If any pipe burst during testing the same shall be replaced & made good by the contractor without any extra cost to the employer.

B1223 INTERLOCKING PAVER BLOCKS

B1223.1 General

B1223.1.1 The section covers fixing of paving blocks of specified width and depth as per specifications/GFC drawings.

B1223.2 Material

B1223.2.1 Strength and Texture

B1223.2.2 Factory made precast paver block of M-30 or otherwise specified grade to be used. Paver blocks to be of approved brand and manufacturer and of approved quality. Minimum strength as prescribed by manufacturer and as per direction of Employer for the grade specified to be tested as per method specified

B1223.2.3 The units as supplied shall be free from cracks that detract from their general appearance.

B1223.2.4 The surface texture and colour of the units shall fall within the range of texture and colour represented by the manufacturer's approved samples. The colour shall penetrate to a depth of at least 5 mm below the wearing surface of each unit and the coloured layer shall be integrally bound to the body of the unit.

B1223.3 Interlocking paver block to be fixed on the bed 50 mm or specified otherwise thick of coarse sand of approved specification and filling the joints with the sand of approved type and quality or as specified and as directed by Employer.

B1224 DEMOLITION / DISMANTLING

B1224.1 General

B1224.1.1 During demolition or dismantling, every precaution shall be taken by the contractor to prevent damage to any part of the structure and also to any adjacent structures which are to be left intact. Any damage caused to the structures, due to the carelessness and negligence of the contractor shall be made good by him at his own expense. Care must be taken by the contractor in such a way that debris shall not fall into water and if falls to be removed immediately.

B1225 ARCHITECTURAL WORKS

B1225.1 Architecture and Finishes

- (a) All works and finishing will be in accordance with the latest Indian Standard specifications and all details and requirements contained in annexures and schedules are in addition to these specifications.
- (b) These specifications are for work to be performed, items to be supplied and materials to be used in the works as shown and defined in the drawings/finishes schedule and List of Approved Makes in the attached annexures and herein to the satisfaction of the Employer.
- (c) If specification for any item of work or material are not available either in Indian Standard Specifications or in these particular specifications, in such cases relevant International Standard specifications or National Building Code (NBC) 2005 shall be followed. In case non-availability of those, prior approval of the Employer will be taken before commencing work.
- (d) The workmanship is to be the best possible and of a high standard. The contractor shall take all steps necessary to address deficiencies, if any, identified by the Employer. Use must be made of special craftsmen / tradesmen in all aspects of the work and allowance must be made. To ensure the same the contractor shall implement a highly effective and comprehensive QA/QC program as stated in general specification and shall adhere to the same.
- (e) The materials to be provided by the contractor shall be in accordance with the samples already approved by the Employer and conform to the specification and approved list of manufacture and brand, as per the attached annexures. The contractor shall produce all invoices, vouchers or receipts for any materials if called upon to do so by the Employer.

- (f) A sample of all materials is to be submitted to the Employer for their approval before the contractor orders or delivers the material to the site. Samples together with their packing are to be provided free of charge by the contractor and should any materials be rejected they will be removed from the site at the contractor's expense. All samples will be retained by the Employer for comparison with materials which will be delivered at site. Also the contractor will be required to submit specimen finishes colours, glass, etc., for approval of the Employer before proceeding with the works.
- (g) All materials to be provided in subject contract shall be ISI marked. In cases where ISI marked materials are not available, materials superior or conforming to BIS standards and approved by the Employer shall be used. Materials for which manufacturers names have been mentioned in contract, makes as approved from list of manufacturers mentioned in contract shall be provided. The manufacturers having ISI marked material shall be preferred.
- (h) Contractor shall maintain uniform quality and consistency in workmanship throughout the execution of the work.
- (i) The contractor shall provide, all materials, labour, maintenance, fixing, carrying, cleaning, and making good, etc. temporary canvas, plastics and any other requisite protection of the works, all the necessary equipment, labour and removal of the same at the completion of the work. The Employer will be the sole judge in deciding as to the suitability of the tools or plants that may be brought on the works by the contractors, for the proper execution of the work.
- (j) All floors, paving, staircase, etc. are to be scrubbed/cleaned, all glazing to be cleaned on both sides of windows/curtain wall including its members, screens, doors, sky-lights, roof lights, etc., all gulley, gutters, pipe heads, etc. to be cleaned out and the premises left clean, perfect and water tight upon completion. However, proper care needs to be taken during such cleaning works so as to ensure no scratch/damage to the original finishing such as polishing, painting, anodizing, powder coating etc. In case of any such damage, the contractor shall have to reinstate the same as original as per the instructions of Employer, without any cost to Employer.
- (k) Templates, boxes and moulds shall be accurately set out and rigidly constructed so as to remain accurate during the time they are in use.
- (l) All unexposed surfaces of timber e.g. backing fillets, backs of door frames, cupboard framing, grounds, etc., are to be treated with two coats of approved timber preservative before fixing or covering.
- (m) Workmanship - All works shall be to true line, level; plumb and square corners and edges in all cases shall be unbroken and finished neat.
- (n) The Employer may order for the inspection of any finished work as he chooses and in a manner, he decides, and the contractors shall bear all expenses in this connection.

- (o) If the results of such inspection prove that the material used and/or workmanship is not of the standard required, the work will be rejected and removed forthwith and be replaced by works of the accepted standard of quality and material without any extra cost.
- (p) The contractor shall produce all invoices vouchers or receipts for any materials if called upon to do so by the Employer.

B1225.2 Shop Drawings

- (a) Shop/fabrication drawings shall be prepared by the contractor for all specialized items of work as indicated in the specifications before starting manufacturing of the items. These shall be carefully prepared in accordance with the specifications and drawings and best trade practices and shall contain all the relevant information required.
- (b) Unless otherwise mentioned, the Employer will take 21 days for approving any drawings/ designs submitted by the contractor for approval. Before submission, the contractor shall check the shop drawings and ensure that these are correct, complete and drawn to the required scale and fully coordinated with all relevant disciplines. Whenever required the contractor shall arrange a meeting of his design consultant with the Employer's designer for any clarifications on the drawings/ design documents submitted for design approval at Employer's designers place at his own cost.
- (c) Shop drawings shall be prepared by the contractor at least for the following works unless specified otherwise: -
 - (i) Structural steel works
 - (ii) External Glazing
 - (iii) ACP/metal Cladding
 - (iv) Aluminium Louvers
 - (v) Tile works
 - (vi) Internal partitions
 - (vii) Toilet Cubicles
 - (viii) Lift Machine Room

B1225.3 Detailed Specifications – Architecture

- B1225.3.1 The latest relevant IS codes applicable as on 30 days prior to submission of the bid, are to be followed for all purposes including workmanship, materials, finishing, warranty etc., unless mentioned otherwise. In case of multiple workmanship procedures or conflicting requirements, prior approval must be taken from the Employer before commencement of work. In case of additional/omitted items not mentioned here, latest Indian Standard Specifications to be followed. These specifications are to be read in conjunction with the Schedule of finishes and the List of Approved Makes in the attached annexures.
- B1225.3.2 The latest Indian Standard Specifications will be applicable for the points mentioned below. The specifications provided herein are additional to IS standards. In case of any discrepancy in the specifications the decision of Employer shall be final.

- (a) Flooring – stone (includes internal, external, staircases and skirting of all stone flooring)
- (b) Flooring – Tile (including skirting)
- (c) Paint works (internal, external, metal, wood)
- (d) Wall cladding
- (e) Fire doors
- (f) Glass (Glazing, Mirror, Partitions etc.)
- (g) False ceilings
- (h) Bathroom fixtures
- (i) Pantry fixtures
- (j) Woodwork - cabinetry and furniture
- (k) Hardware / ironmongery
- (l) Structural glazing
- (m) Safety and architectural railings

B1225.4 Waterproofing and Insulation

B1225.4.1 These specifications cover the general requirements of waterproofing systems to the various parts of the structure. The contractor shall consider the prescribed requirements carefully and assess the best suited system for a particular part of the structure, keeping in mind the heavy rainfall of the region and high water table possibility. The contractor is fully and totally responsible to provide buildings and infrastructure that are water tight and leak proof. The contractor will submit a waterproofing and sealant plan to be approved by the Employer.

B1225.5 Codes References

- (a) IS 73: Paving Bitumen Specifications
- (b) IS 702: Specifications for Industrial Bitumen
- (c) IS 1322: Specifications for Bitumen felts for Water Proofing and Damp Proofing.
- (d) IS 2645: Specifications for Integral Cement Water Proofing Compounds
- (e) IS 3370: (Part -1) Code of Practice for Concrete Structures for the Storage of Liquid: Part -1 General Requirements.
- (f) IS 3384: Specifications for Bitumen Primer for Water Proofing and Damp Proofing
- (g) IS 7193: Specification for Glass Fibre Bitumen Felts
- (h) IS 12200: Provision of Water Stops at Transfers Construction Joints in Masonry and Concrete Dams - Code of Practice.
- (i) IS 12432: (Part-3) Application for Spray Applied Insulation-Code of Practice Part-3 Polyurethane/ Polyisocyanurate

B1225.6 General Waterproofing Requirements

- (a) The work shall be carried out by an approved specialised waterproofing agency that has a minimum of ten (10) years' experience in the proposed waterproofing systems.

- (b) The specifications given below against each item are indicative in nature. The contractor in consultation with the proposed specialised waterproofing agency shall propose their detailed specification in line with the requirements given below and shall submit such specifications for approval by the Employer.
- (c) On completion of the works, Contractor has to submit a comprehensive guarantee valid for minimum 10 years.
- (d) The extent of waterproofing required for different structural elements shall be as approved by the Employer and Contractor's specifications shall match such requirements.
- (e) In case of exposed water proofing treatments, required slopes shall be given to the finished surfaces of waterproofing treatment to ensure drain out of water in the desired direction.
- (f) A shop drawing shall be submitted for review before executing the treatments with all relevant details of rainwater down take pipes, flashing, coving, ridge, valley, drip moulds etc.
- (g) The rate quoted shall include all preparatory works to affect a defect free treatment, staging, scaffolding, curing, cost of all chemicals, dewatering, ponding test for the duration as instructed by the Employer, protection against damages of waterproofed layer, working at all levels and heights etc.
- (h) Ponding test is mandatory over all water proofing works for the durations as specified by the Employer.

B1225.7 Material Requirements

- (a) Acceptable Manufacturers:

The following is a list of acceptable manufacturers but is not limited to and may be amended upon showing relevant and merit supporting evidence: Pidilite, BASF, Fosroc, Sika, Cico and MC Bauchemie.

- (b) Acceptable Proprietary Products:

The following is an indicative, non-exhaustive list of proprietary products. On par or better solutions may be finalised with guidance of a waterproofing specialist or consultant.

- (i) Acrylic Polymer Modified Cementitious system

- Dr.Fixit Pidifin 2K (Pidilite)
- Brushbond (Fosroc)
- Top Seal-107 (Sika)
- Tapecrete P151 (Cico)
- Masterseal 399/561 (BASF)

- (ii) APP/SBS polymer reinforced membrane system

- Dr.Fixit Torchshield (Pidilite)
- Proofex Torchseal 3P & 4P (Fosroc)

- Masterpren 2003 (BASF)
 - BituSeal T-130 SG (Sika)
 - Cico Shield (Cico)
 - Dictagum 30 SF (MC Bauchemie)
- (iii) Liquid applied elastomeric polyurethane membrane system
- Dr.Fixit Flexicoat or Roofseal (Pidilite)
 - Nitoproof 800 (Fosroc)
 - Masterseal HLM 5000 (BASF)
 - Sikalastic 560 (Sika)
 - Corchem 206 (Cico)
 - Dictaflex 600 (MC Bauchemie)
- (iv) Spray applied polyurethane foam system
- Dr.Fixit Blueseal (Pidilite)
 - Polyurea Solutions (Fosroc)
 - Elastocoat (BASF)
 - Sikaboom (Sika)
- (c) Source Quality:
The contractor must obtain proprietary waterproofing products directly from the manufacturer.
- (d) Other civil material related with waterproofing:
The contractor must obtain cement, screened river sand, brick-bats, aggregates, integral waterproofing compounds, etc. required for screeds, protective toppings and plasters shall conform to the pertaining IS standards (IS 269, IS 8112, IS 13286, IS 383, IS 2645, IS 12118 and IS 3495). The Employer may demand the conformance of these materials from the Specialised Executing Waterproofing Agencies / civil contractor from time to time and they shall have to produce test reports / documents to prove the conformance of these materials with their applicable standards, without any argument.
- (e) Mixes:
The contractor must mix waterproofing material as specified by the manufacturer. Follow exact instructions as mentioned in the respective technical literature. Mix waterproofing in quantities that can be applied within 20 to 30 minutes from time of mixing. The liquid applied coatings/membranes may be applied by brush, roller, squeegee, trowel or spray. Prefabricated membranes may be applied by priming and torching or as specified in the manufacturer's literature.

B1225.8 Execution

(a) Examination

(i) Site Visit:

Prior to waterproofing installation, arrange visit to project site with waterproofing manufacturer's representative. Representative shall inspect and certify that concrete surfaces are in acceptable condition to receive the waterproofing treatment.

(ii) Verification of Substrates:

Verify that concrete surfaces are sound and clean, and that form release agents and materials used to cure the concrete are compatible with waterproofing treatment.

(iii) Examination of Defects:

Examine surfaces to be waterproofed for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks. Such defects are to be repaired in accordance to manufacturer's product data and point (b) below.

(b) Preparation

(i) Concrete Finish:

Prior Concrete surfaces to receive waterproofing treatment shall be free from scale, excess oil, laitance, curing compounds and foreign matter. Horizontal surfaces shall have a rough wood float, smooth or broom finish, as required by the waterproofing manufacturer.

(ii) Surface Preparation:

Smooth surfaces (e.g. where steel forms are used) or surfaces covered with excess form oil or other contaminants shall be washed, lightly sandblasted, water blasted, or acid etched with muriatic acid (as necessary) to provide a clean absorbent surface. Surfaces to be acid-etched shall be saturated with water prior to application of acid.

(iii) Repair of Defects:

Form Tie Holes, Construction Joints, cracks: Chip out defective areas in a 'U' shaped slot 25 mm wide and a minimum of 25 mm deep. Clean slot of debris and dust. Soak area with water and remove excess surface water. Apply a polymer modified cementitious bonding coat of approved material to the slot. Then fill cavity with a non-shrink, waterproof, cementitious grout / mortar, while the bonding coat is tacky.

(c) Application

(i) Construction Joints:

Apply cementitious bonding material in slurry form to joint surfaces between concrete pours, just prior to pouring fresh concrete. Moisten surfaces prior to the bonding coat application. Where joint surfaces are not accessible prior to pouring new concrete contractor must consult manufacturer for application procedure.

(ii) Coves:

Make a minimum 4 inch (diagonal) cove at all 900 interfaces in concrete surfaces where waterproofing is carried out, without fail.

(iii) Surface Application:

After repairs, surface preparation, treatment of construction joints, cracks, honeycombs, tie-holes, etc., have been completed in accordance with manufacturer's product data and as specified herein, apply/provide the waterproofing material as specified in the manufacturer's technical and application data sheet to concrete surfaces. Application rates, thicknesses and locations shall be as indicated in the drawing. When brushing, work slurry well into surface of the concrete, filling surface pores and hairline cracks. When spraying, hold nozzle close enough to ensure that slurry is forced into pores and hairline cracks. When torching, uniformly burn the surface when overlapping, to ensure that the membrane adheres uniformly.

(iv) Sandwich (Topping) Application:

When treated structural slabs are to receive a concrete or other topping, place the topping only after the initial curing period of the material is being used, is completed. Lightly pre-water when rapid drying conditions exist.

(d) Application

(i) General:

For cementitious materials, begin curing as soon as the applied waterproofing material has hardened sufficiently so as not to be damaged by a fine spray. Cure the treatment with water as per the manufacturer's instructions. In warm climates, more-than-normal curing duration may be necessary to prevent excessive drying of coating. For liquid applied membranes / Pre-fabricated membranes, natural air curing for duration as described in the manufacturer's technical data sheet.

- (ii) Air circulation:

Do not lay plastic sheeting directly on the waterproofing coating as air contact is required for proper curing. If poor circulation exists in treated areas, it may be necessary to provide fans or blown air to aid curing of waterproofing treatment.
- (iii) Protection:

During the curing period, protect the treated surfaces from damage by wind, sun rain and temperatures below 20 C. If plastic sheeting is used for protection, it must be raised off the waterproofing coating to allow sufficient air circulation.
- (e) Interface with other materials
 - (i) Backfilling:

Do not backfill for 36 hours after application. If backfill takes place within seven days after application, then backfill material shall be moist so as not to draw moisture from waterproof coating.
 - (ii) Paint, epoxy or similar coatings:

Do not apply paint or other coatings until waterproofing treatment has cured and set for a minimum of 21 days. Before applying or coating, neutralize treated surface by dampening with water and then washing waterproofed surface with 15% (HCL) muriatic acid, diluted in a ratio of one part acid to four parts water by volume. Flush acid off treated concrete surfaces.
 - (iii) Grout, Cement Parge Coat, Plaster or Stucco:

Because the waterproof coating forms a relatively smooth surface and the resulting waterproof coating reduces the suction characteristics of the concrete, it may be necessary to use a suitable bonding agent for proper bonding of cementitious systems (IPS, screed, plaster, etc.) if they are applied.
 - (iv) Responsibility to Ensure Compatibility:

The respective manufacturers' must confirm in writing regarding compatibility of their waterproofing treatments with other coatings, plaster, stuccos, tiles or other surface-applied materials. It shall be the responsibility of the manufacturer / installer of the waterproofing material to take whatever measures are necessary, including testing, to ensure acceptance by or adhesion to their waterproofing system.
- (f) Field Quality Control
 - (i) Observation:

Do not conceal installed waterproofing system before it has been observed by Employer, waterproofing manufacturer's representative and other designated entities.

- (ii) Flood Testing:

Perform flood test on completed waterproofing installation for a minimum of 72 hours before of other construction. Plug or dam drains and fill area with water to a depth of at least 100mm. If leaks are discovered, make repairs and repeat tests until no leaks or dampness is observed.
- (g) Cleaning & Protection
 - (i) Cleaning:

Clean spillage and soiling from adjacent surfaces using appropriate cleaning agents and procedures. Ensure that cleaning agents do not harm or damage the waterproofing coating in any way what so ever.
 - (ii) Protection:

Take measures to protect completed waterproofing system from damage immediately after application. Do not permit traffic on unprotected coating or membrane.
- (h) Areas of Application & Indicative Method
 - (a) Roof Waterproofing
 - (iii) Using Atactic Polypropylene (APP) or Styrene Butadiene Styrene Based (SBS) Membrane

Supplying, providing and applying water proofing treatment with membrane type water proofing methods using 4mm thick polymer modified Bituminous membrane of approved makes of either Styrene Butadiene Styrene (SBS) based or Atactic Poly-Propylene (APP) based with UV resistant, ground chemical resistant, high melting points, flexible and elastic with high adhesive strength. The membrane shall be reinforced with non-woven polyester reinforcement of minimum of 180 g/sqm including coating with compatible primer of bituminous base and torch application with overlap of 100 mm wherever required. The reinforcement provided shall be able to withstand the traffic flow density and after construction, shall carry a minimum guarantee period of 10 years. Cost to include laying loosely over the surface / after priming and torching the prefabricated overlap at ends. The slope making part consists laying of 110 mm average thick light weight concrete of specified grade mixed with water proofing admixture as per manufacturers specifications approved by Employer with a minimum guarantee period of 10 years. Cost to include cement slurry with water proofing compound applied over the surface after cleaning the surface, laying of light weight concrete to necessary gradient and joint free water proof plastering in CM 1:2 and impression marking. Treatment must continue along the parapet wall for 300 mm height in the shape of round vata along with curing and all other associated tasks.

The laying of light weight concrete is by using light weight aggregates of perlite having higher compressive strength and highest fire resistance with thermal / acoustic insulation properties, anti-corrosion, anti-condensation, etc. of perlite in the required proportion to get the desired density, mixing, transportation, placing, compacting and finishing to the required level with necessary side supports, equipment's, etc. complete

(b) Waterproofing to Toilet and Pantry

Providing and laying water proofing in toilet & pantry water proofing treatment on RCC roof surface etc, by applying Polymer modified cementitious slurry mixed with Water Proofing Component consisting of following layers: (i) first layer of slurry of cement @ 0.488 Kg. /sqm mixed with Water Proofing Component @ 0.253 Kg/sqm. This layer will be allowed to air cure for 4 hours. (ii) Second layer of slurry of cement @ 0.242 Kg/sqm mixed with Water Proofing Component @ 0.126 Kg/sqm. This layer will be allowed to air cure for 4 hours followed by water curing for 48 hours. The rate includes preparation of surface treatment & sealing of all joints corners, junction with polymer mixed slurry etc. complete in all respect, as per the specifications, drawing & as directed by Architect / Employer. This treatment to continue to the toilet walls upto 900mm height. Curing / testing by stagnating water for a period not less than 72 hrs.

(c) Lift Pit Waterproofing

Protective coat to water proofing system: Applying cement sand (1:4) screed 20mm thick with integral waterproofing compound as protective layer over the waterproofed surface as per specification and as directed by the Employer. Fixing of specified and approved polystyrene board over the as protective layer over the waterproofed wall surface as per specification and as directed by the Employer.

(a) Roof Finishes (wherever applicable)

Providing and laying 20 mm thick Pressed Clay Tiles of approved make (sourced from Calicut or Trissur) laid over 20 mm thick cement mortar 1:3 mixed with crude oil 10% by weight of cement and pointing of joints in same mortar including waterproofing compound, including flashing of corners, the tiles shall be laid with clear slope such as to avoid water stagnation, the works shall be complete as per specification and as directed by the Employer

(b) Expansion Joints (wherever applicable)

Providing and laying waterproofing of expansion joint, as per specifications herein with a minimum guarantee period of 10 years: The first part consisting of providing and fixing the Polyethylene backer, then wire-brushing the internal sides of the concrete where the sealant is to be applied. Also, wire-brushing is to be done on the top surface of the concrete up to 200mm on either side of the expansion joint. The second part consists of providing and fixing the polyethylene backer sheet into the expansion joint leaving specified depth from the top of the slab. The third part consists of providing and applying Polyurethane primer coating onto the sides of the expansion joint up to the specified depth from top of the slab. The fourth part consists of providing and filling Polyurethane sealant having elongation of 500% into the slot up to the surface of the slab.

B1226 VITRIFIED TILE FLOORING & SKIRTING

B1226.1 General

B1226.1.1 The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be nominal size of 80cm x 80cm or 60cm x 120cm and of thickness as per requirement and as directed and approved by the Employer. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

B1226.1.2 The top surface shall be free from welts, chips, craze, specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one meter. The top surface shall be either polished or matt as specified.

B1226.2 Surface quality

B1226.2.1 Minimum 95% of tiles shall be free from visible defects that would impair the appearance of a major area of tiles.

B1226.3 Dimensions and Tolerances

B1226.3.1 The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties. Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with joints matching the pattern of floor tiles) match with dimensions of full tiles.

B1226.4 Preparation of Surface and laying.

- All new substrata shall be allowed to cure and dry completely according to standard practice. The base should be hard and strong and free from random cracking and potholes.
- Adhesive must be applied to the prepared surface using a Notch trowel. It is important to spread the right quantity of adhesive for good Adhesion to the slab. For large area flooring leave Expansion and contraction joint between tiles to prevent cracks. Minimum 2 mm Spacer is recommended in the joints. Leave 6 mm small gap between the wall & end tile and fill the gap with dry sand. Leave 2 mm small gap between top face of the flooring and the underside of the skirting tile on all the four sides of the wall.
- Before fixing vitrified tiles lay them out in the desired pattern and make sure that they give an acceptable blend of colour. For fixing vitrified tiles, use good quality chemical fixing adhesives with proper trowelling method for 100% coverage behind the tile and for peerless bonding. Do not use as iron hammer or some heavy material to press the tile.
- The work size will be as per ISO specifications. As part of internationally accepted laying practices, use of 2 to 5 mm spacers recommended. Complete the tiles laying process by pressing the cut tiles firmly into place along the walls/floors. Allow a minimum of 48 hours for bed curing. After this period fill the joints with grouts with recommended joints. Usage of grout sealant is recommended for keeping the grout free of dust. 15 minutes after finishing the grouting process, wipe off excess grout with a damp sponge and polish the tiles with a soft and dry cloth for a clean surface as directed by Employer. The finished surface shall be protected properly using 5mm thick tile protection sheet till handover the site.

B1226.5 Tests

B1226.5.1 All tests to be conducted as per IS 13630 part 1 to 8 and ISO 10545 part 1 to 14

Material	Test	Field/ Laboratory test	Test Procedure	Min. qty of material for carrying out the test	Frequency of test
Vitrified tiles	1.Dimension s and surface quality 2.Physical properties 3.Chemical properties	Laboratory	IS:13630	3000 nos	One test for every 3000 Nos. or part thereof for each type and size from a single manufacturer. (One test to be done even if the number tiles of any type and size from a single manufacturer is less than 1500 Nos. provided the total number of tiles of all types and sizes from all manufacturers used in a work exceed 1500 Nos.

B1226.6 Acceptance Criteria

For Polished/Matt vitrified tile

S.No.	Property	Standard Laid Down
1.	Deviation in Length	± 0.05%
2.	Deviation in Thickness	± 3%
3.	Deviation Straightness of side	± 0.05%
4.	Deviation Rectangularity	± 0.1%
5.	Deviation Surface Flatness	± 0.1%
6.	Water absorption	≤0.05%
7.	Mohs Hardness	≥7
8.	Modulus of rupture	≥45N/mm ²
9.	Abrasion Resistance	<144 MM ³
10.	Skid Resistance	>0.4
11.	Breaking Strength	≥2200 N

S.No.	Property	Standard Laid Down
12.	Density (G/CC)	>2.4gm/cc, min
13.	Frost Resistance	Frost proof
14.	Chemical Resistance	No Damage
15.	Thermal Shock Resistance	10cycles. min
16.	Colour Resistance	No Damage
17.	Thermal Expansion	$<6 \times 10^{-6} \text{ K}^{-1}$

B1227 CEMENT BASED HIGH POLYMER MODIFIED QUICK SET ADHESIVE (WATER BASED)

High polymer modified quick set tile adhesive is conforming to IS 15477.

(1) Surface Preparation

Substrate must be perfectly clean. Remove all loose grit, dust & debris from the substrate either wall / floors. Clean the surface properly. Do not allow to pond the water on such areas. Pre-soaking method enhances the adhesion to substrate.

(2) Mixing

- Blend 25 kg of material to approx. 5 ltrs of clean water. Always add powder to water, never pour the water to powder. The quantity may vary slightly, and it can be adjusted depending upon the ambient conditions. Mix minimum 3 minutes to obtain a lump free consistency with using slow speed drill. Recommended to use mixing pedal to achieve proper chemical properties and a homogeneous mixer. Spread the mixed adhesive to the substrate at a minimum thickness specified using notched trowel.
- For better adhesion result, do not spread more than 1 m² of adhesive at a time. Once spread the adhesive, immediately within 15 minutes at temperature <35⁰C fix the tiles on adhesive and press the tiles firmly.
- Do not fix the tiles on applied adhesives after 35 minutes. For such delays remove the adhesives from the substrate and provide fresh materials.
- The mixed adhesive should be used within 45 minutes stipulated time at an average ambient temperature of 35 ⁰C. At Extreme ambient (Above 35 ⁰C) temperature, remix the adhesive, adjust the consistency and continue the application. Excess materials to be removed from the tiles using sponge & clean water.
- On extreme climatic conditions repeated dampening of substrate is necessary. Any stain or dirt can be removed from the tiles using tile cleaning compound.

(2) Application

- High polymer modified quick set tile adhesive (conforming to IS 15477) shall be thoroughly mixed with water as per manufactures specification and a paste of zero lump shall be prepared so that it can be used within 1.5 to 2 hours. It shall be spread over an area not more than one sqm at one time. Minimum thickness of adhesive shall be 6 mm. The adhesive so spreaded shall be combed using notch trowel.
- Tiles shall be pressed firmly into the position with slight twisting action, checking it simultaneously to ensure good contact gently tap with wooden mallet till it is properly backed with adjoining tiles. The tiles shall be fixed within 15 minutes of application of adhesive. The surplus adhesive from the joints, surface of the tiles shall be immediately cleaned.
- Where full size tile cannot be fixed these shall be cut (water jet cutting) to the required size and edges rubbed smooth to ensure straight and true joints.
- The surface of the flooring shall be frequently checked during laying with straight edge of above 2m long so as to attain a true surface with required slope.

B1228 RESIN BASED EPOXY GROUT FOR SPACER FILLING

B1228.1 Water-resistant grouting of joints with high chemical and mechanical resistance and a high level of hardness epoxy grout and confirming to British Standards 5980:1980 or relevant Indian Standard

B1228.2 Surface Preparation

B1228.2.1 The joints shall be cleaned off with brush or air blower and all dust and loose particles removed. Joints shall then be filled with approved grouts.

B1228.2.2 For exterior-grouting application, clean the tile/slab joints properly prior to applying epoxy and ensure that any standing water does not remain in the grouting areas.

B1228.2.3 Application areas must clean and dry prior to the grouting applications. Better surface preparation enhances the adhesion properties and performances.

B1228.3 Mixing

B1228.3.1 Epoxy is a two-part system. Strictly recommended to use a slow speed drill and mixing blades. Use an empty cleaned container for mixing. Mix by adding the entire reactor to the base and stir thoroughly, then add the filler slowly and keep stirring until a smooth and lump free paste is obtained. It is recommended to mix total quantity at one time.

- B1228.3.2 Place an empty bucket and add Part A (**Hardener**) and followed by the Part B (**Base**) and mix with slow speed mix and continue the mixing for 3 minutes to obtain homogenous mix. Do not add any other materials.
- B1228.3.3 The colour grouts should be mixed properly, until the colour pigments gets completely dissolved in the mix. If the pigments not dissolved in the mix, the result of grout colour shall vary.
- B1228.3.4 When the grout mortar has become too stiff after the stipulated time, the mixed materials should be discarded and a new batch should be prepared.
- B1228.4 **Application**
- B1228.4.1 Grouting application should be carried out after 48 hours of tile installation. Grouting application should not be done during extreme hot (>45^o C) climatic conditions.
- B1228.4.2 Apply to all the tile/slab joints and porous areas on the tile/slab with a plastic spatula, working not more than half square meter at a time. Remove surplus grout before it sets with a cloth soaked in clean water. The pot life is about 30 minutes after mixing depending on the ambient temperature.
- B1228.4.3 The mixed materials should be used within 30 minutes at an average 35 °C of ambient temperature. The mixed grout materials apply to the joints from the both sides with using spatula. Best results can be obtained by filling the joints with grout and flush the surface of tile/slab using a hard rubber float, working diagonally across the grout joints to both fill and compact the joints. All excess grout materials should be removed with sponge/white cloth before the initial setting.
- B1228.4.4 However, it is important to allow the grout to firm in the joint acquiring its initial set before any further cleaning is to be done without concerning about the dried grout left on the surface of the tile/slab. After the initial set of the grout, clean the surface with a pad of cheese cloth or towel dampened with minimum amount of clean and cool water by rubbing in a circular motion to further compact the grout.
- B1228.4.5 For the better, smooth and uniform grout finishes, use bend cable and pull along the joints. The remaining surface grout on the tile/slab can also be cleaned at this time for better finish masking tape shall be used. Scotch bright pad fastened to a float works very well to remove grout from the porous tiles.
- B1228.4.6 Do not pond the water on the grouted areas before complete drying.
- B1228.5 **Tools Cleaning**
- B1228.5.1 Use water to clean the tools before it set. Surplus materials form tiles/slabs should be cleaned with water absorbed cloth or sponge before initial setting.
- B1228.6 **Melamine finish**
- B1228.6.1 Timber works shall be finished by the application of two coats of an acid catalyzed clear lacquer (melamine) wherever it is indicated in the drawing. The finish shall be a satin, semi-gloss finish and shall be carried out as follows:

- (a) The base shall be sand papered to the desired finish and coated with a colour tinge to give it shade. The shade shall be sealed with a coat of spirit finish.
- (b) After the base, first coat of lacquer shall be applied evenly by a soft cloth or by spray to give an even coat to the veneer surface.
- (c) After the first coat has fully dried, the lacquered surface shall be rubbed down in the direction of the veneer grain with very fine glass paper and left completely smooth and clean before the second coat is applied.
- (d) When the second coat of lacquer is fully dry, the surface shall be rubbed down in the direction of veneer grain with very fine wire wool dipped in a petroleum-based wax to give lubrication.
Twenty-four hours after completion of this process the lacquered veneer surface shall be finished by burnishing with a soft cloth to an approved finish.

B1229 FALSE CEILING

B1229.1 Calcium Silicate False Ceiling

B1229.1.1 Providing and fixing false ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of calcium silicate board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound , jointing tapes , finishing with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed.

B1229.1.2 Grid Ceiling (With Mineral fiber tiles/ Moisture resistant mineral fiber tiles)

- B1229.1.3 Providing and fixing tiled false ceiling of approved materials of size 595x595 mm in true horizontal level, suspended on inter locking metal grid of hot dipped galvanized steel sections (galvanized @ 120 grams/ sqm, both side inclusive) consisting of main “T” runner with suitably spaced joints to get required length and of size 24x38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to center and cross “T” of size 24x25 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main “T” at 600 mm center to center to form a grid of 1200x600 mm and secondary cross “T” of length 600 mm and size 24x25 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and wall angle of size 24x24x0.3 mm and laying false ceiling tiles of approved texture in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc.
- B1229.1.4 Main “T” runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm GI adjustable rods with galvanized butterfly level clips of size 85 x 30 x 0.8 mm spaced at 1200 mm center to center along main T, bottom exposed width of 24 mm of all T-sections shall be pre-painted with polyester paint as per specifications, drawings and as directed by Employer.
- B1229.2 **Extruded Baffle Aluminum False Ceiling**
- B1229.2.1 Providing and fixing Extruded Baffle Aluminium panel ceiling manufactured by M/s Hunter Douglas India Pvt. Ltd or equivalent as of approved colour consisting of panel size 50mm wide x100mm deep width having 1.2mm thick powder coated Aluminium in wood grain finish, maximum panel length up to 4 mtr. Baffle Panels will be powder coated with wood finish colour with min 60microns on the exposed surface. Panel to be connected using fasteners to the primary Steel carrier of 30 mm wide x 30 mm high x 2 mm thick with module option of Holes @ 25mm C/C. Primary steel carrier shall be suspended by means of threaded rod at a distance of 1.00 mtr c/c. System Module will be 300mm c/c as per the Architect/Employer specified. The end caps need to be powder coated with wood finish as same as baffles. The system shall be fixed to steel substructure at maximum 1000mm/c by means M8 bolts and nuts with washers.
- B1229.2.2 **Paint Finish:** The panels will be pre-treated in latest Nano technology process and electro statically powder coated with automatic Corona system and cured with gas catalytic technology and the baffles finished with wood grain finish.
- B1229.3 **Polycarbonate**
- B1229.3.1 Providing & fixing Poly carbonate multi wall plain sheet 8 mm thick as approved by the Employer and should be supplied in a single length of 12 M or as decide by the Employer. The sheets shall be fixed using self-drilling/self-tapping screw of size (5.5x55mm) with EPDM seal complete upto any pitch in horizontal /vertical / curved surface, but excluding the cost of purlins, rafters, trusses, and including cutting to size and shapes where ever required.

B1230 WOODWORK AND JOINERY

B1230.1 General

B1230.1.1 Reference shall be made to the following Indian Standards for further information etc. not covered in the specification. In case of any conflict/contradiction the provisions of the specification shall override.

- (a) IS:205 Specifications for non-ferrous metal butt hinges
- (b) IS:287 Recommendation for maximum permissible moisture content of timber used for different purposes.
- (c) IS:303 Specification for plywood for general purpose.
- (d) IS:362 Specification for parliamentary hinges
- (e) IS:419 Specification for putty for the use on window frames
- (f) IS:883 Code of practice for design of structural timber in building.
- (g) IS:1003 Specification for timber panelled and glazed shutters Part II - Window and ventilator shutters.
- (h) IS:1200 Method of measurement of building and civil part XXI Engineering works - wood work and joinery.
- (i) IS:1341 Specification for steel butt hinges
- (j) IS:1658 Specification for fibre hard boards
- (k) IS:1761 Specification for transparent sheet glass for glazing and framing purposes.
- (l) IS:3087 Specification for wood particle boards (medium density for structural timber in building)
- (m) Other I.S. codes not specifically mentioned here but pertaining to wood work and joinery form part of these specifications, along with for all seasoning, workmanship, fitting and finishing.

B1230.2 Woodwork:

B1230.2.1 Timber used shall conform to specifications described under materials, shall be in accordance with the drawing in every detail and all joiner's work shall be accurately set out, framed and finished in a proper workman like manner. Frames of partitions and opening, etc., shall be of accurately planned smooth and rebates, rounding and mouldings shall be made as shown on the drawings. Patching or Plugging of any kind shall not be allowed. Joints shall be simple, neat and strong. Framed joints shall be coated with suitable adhesive like glue or synthetic resin before the frames put together. All mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be pinned with hardwood or rust resisting star shaped metal pins of 8 mm dia., after the frames are put together and pressed in position by means of a press. The frames shall be protected during the progress of work by providing suitable boxing. All portions of timber abutting against or embedded in masonry or concrete shall be treated against termites by giving a coat of any approved wood preservative. All teak wood work should be painted with a coat of approved wood primer.

B1230.2.2 Frames and Shutters shall not be painted or erected before being approved by the Employer.

B1230.3 Joinery

B1230.3.1 Any portions that are warped or found with other defects are to be replaced before wedging up. The whole of the work is to be framed and finished in a workmen-like manner in accordance with the detailed drawings wrought and whenever required, fitted with all necessary metal ties. Straps, belts, screws, glue etc. Running beaded joints are to be cross-tongued with teak tongues wherever 1(1/2) thick. Double cross tongued. Joiners work generally to be finished with fine sand/glass paper.

B1230.4 Joints

B1230.4.1 All joints shall be standard mortise and tenon, dowel, dovetail, and cross halved. Nailed or glued butt joints will not be permitted, screws, nails etc. will be standard iron or wire of oxidized Nettle fold tenons should fit the mortises exactly.

B1230.4.2 Nailed or glued butt joints will not be permitted, exceptional cases with approval of Employer.

B1230.4.3 Where screws shown on a finished surface, those will be sunk and the whole plugged with a wood plug of the same wood and grain of the finished surfaces will be neatly punched and the hole filled with wood filler to match the colour. Should joints in joiner's work open, or other defects arise within the period stated for defect liability in the contract and the clause thereof be deemed by the Architects to be due to such defective joinery shall be taken down, and refilled, redecorated and/or replaced if necessary and any work disturbed shall be made good at the Contractor's expense.

B1230.4.4 Nails, spikes and bolts shall be of lengths and weights approved by the Employer. Nails shall comply with IS 1959-1960. Brass headed nails are to comply with B.S.1210. Wire staples shall comply with B.S.1494 or equivalent. The contact surface of dowels, tenons, wedges etc., shall be glued with an approved adhesive.

B1230.4.5 Where glued, joinery and carpentry work are likely to come into contact with moisture; the glue shall be waterproof grade.

B1230.5 Anodized Aluminium

B1230.5.1 Providing and fixing anodized aluminium (anodized transparent or dyed to required shade according to IS: 1868. Minimum anodic coating of grade AC 15) sub frame work for cladding works/partition works etc. with extruded built up standard tubular section of approved make conforming to IS: 733 and IS: 1285, fixed with dash fastener of required dia and size.

B1230.5.2 Standard aluminium extrusion sections are manufactured in various sizes and shapes in wide range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electrocoating plants which ensures uniform coating in uniform colour and shades. The extrusions are anodized up to 30 microns in different colours. The anodized extrusions are tested regularly under strict quality control adhering to Indian Standard.

B1231 ALUMINIUM WORKS & GLAZING

B1231.1 Aluminium Extrusions

B1231.1.1 Providing and supplying aluminium extruded tubular and other aluminium sections approved make confirming to IS:733 & IS:1285 as per the architectural drawings and approved shop drawings, the aluminium quality as per grade 6063 T5 or T6 as per BS 1474, including super durable powder coating of 50-80 microns conforming to AAMA 2604 of required colour and shade as approved by the Architect/ Employer.

B1232 SPIDER GLAZING

B1232.1 Design Criteria

B1232.1.1 The design of structural glazing should be done as per site condition.

B1232.1.2 These glass assemblies are to be designed as load bearing material withstanding the stresses inherent in such assemblies. The above system shall meet the following design parameters and will also comply with BS / Indian Standard Specifications and Codes of Practice. Aesthetically the design of the Glazing system should give uniform appearance.

B1232.2 Preliminary Works such as Making Layout

B1232.2.1 The work under this section includes all labour, materials, equipment and services as required for the complete design, Engineering, fabrication, assembly, delivery, anchorage and installation of the suspended glazing in accordance with the true intent and meaning of the specification and drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings or described in the specification provided that the same can be reasonably inferred there from. Anchorage includes all primary and secondary anchor assemblies and supportive structural framing as required to secure the system.

B1232.3 Frameless toughened glass assemblies

This shall comprise of the following elements:

- (a) 13.52mm, any other laminated toughened Indian Clear Glass, as per design requirement of Approved make,
- (b) Chemical Inserts in concrete for the anchorage of all work under this section if required.
- (c) All steel structural brackets and beam supports, anchors and attachments required for the complete installation of the whole system.

- (d) All caulking, sealing and flashing including sealing at junctions wherever required.
- (e) Sealants within and around the perimeter of all work under this section.
- (f) Engineering proposals, drawings and data.
- (g) Shop drawings, Engineering data and structural calculations of the framing, fasteners and claddings stamped by a professional Structural Employer approved by the Employer.
- (h) Scheduling and monitoring of the work.
- (i) Co-ordination with work of Main Contractor and other trades.
- (j) All final exterior and interior cleaning of the glazing systems.
- (k) Cost of all hoisting, staging and temporary services.

B1232.4 General Specifications

B1232.4.1 Contractor for the toughened glass assemblies shall fabricate, supply and erect and install in position the glazing forming uninterrupted structural glazed surface in accordance with architectural elevation and layout drawings. The glazed surface shall be formed by a frameless system, which shall be of structurally and mechanically designed technology for fabrication and erection.

B1232.4.2 The perimeter of the frames shall be structurally integrated to form air and waterproof movement joint on all four sides of each panel. Design and sealing of such joints shall ensure that there is no penetration of rainwater through these joints under heavy wind pressure.

B1232.4.3 The contractor must comply with all relevant Indian Standards, Code of Practice and technical literature relating to best practice pertaining to frameless toughened glass assemblies. The equivalent International Standards may be used where these are not lower. Nothing in this clause shall relieve the contractor of his obligation to provide a higher standard where required and directed.

B1232.5 Glazing work

- The facade shall be of laminated toughened glass as per specification and shall be supported against wind loads by fins, stiffeners of toughened glass of design thickness. The fins shall be attached to the facade glass and shall be attached to the building structure in such a way as to provide the facade with support against wind loads.
- The glazing system shall be as per drawings and details enclosed.
- The glass panes shall be of the type and thickness specified in the item and their sizes shall be as shown in the drawings. The glass panes shall be of approved quality and make. They shall have properly squared corners and straight edges. Damaged or defective glass shall be replaced with new glass at no additional cost.
- Each piece of glass shall be delivered with factory labels intact, indicating glass type, quality and thickness. Labels shall not be removed until installation has been accepted.

- Glass assembly shall generally be installed from external scaffold or from a mobile scaffold provision of which shall be the responsibility of Glazing contractor including dismantling on Completion of work.
- Tenderer shall submit details of proposed method of installation. Removable protective peel off film should be provided to exposed surfaces on inside and outside faces of the glazing surfaces wherever necessary and should be removed and cleaned by the Glazing contractor when instructed on completion of work. No separate payment will be made for the same.
- Glass is to be protected from breakage immediately upon installation by applying suitable warning markings.
- Sealants of high quality, silicone, as specified by the manufacturers shall be used.

B1232.6 Performance Criteria

- The Contractor shall be responsible for the quality and efficiency of the design and application of the technology offered. The system offered shall be structurally sound, capable of withstanding loads and thermal and structural movements indicated with failure, aesthetically pleasing and in accordance with International Standards.
- The contractor shall submit detailed calculations of the structural design of the main system, fins, factory formed glazed units and withstanding strength of glass to meet with all the design parameters and requirements contained in these specifications.
- The glazing contractor should obtain certificates from glass processor that the product supplied in each lot meets all the requirements contained in the specification. A sample of 1ft x 1ft should be submitted along with each lot supplied.
- The system shall be capable of accommodating all stress and movements that are likely to occur during normal life of 20 years of the suspended glazing members and not less than 10 years for structural silicone sealant.
- Composition of members shall be fully adequate to totally resist distortion such that no distortion takes place.
- Deflection shall not be more than L/60 of the span of the members.
- The Glazing system shall allow a standard deflection of L/175 and shall also accommodate variable deflection limits.
- All the members at each joint shall be in perfect line and alignment. Tolerance for plumb of Spider Glazing installed shall be within $\pm 3\text{mm}$. And shall be as per international practice.

B1232.7 Limiting Factor on Height

- B1232.7.1** It is the responsibility of the Contractor to adequately check the Limiting conditions prior to fabrication and approval on the same is to be acquired in this regard.

B1232.8 Fail-Safe Requirements

B1232.8.1 The design of the toughened glass assembly shall be such that the breakage of any component of the assembly will not initiate progressive collapse of the remainder.

B1232.9 Glass Design Stress

- The glass facade panels and the stiffener fins, and the fixing points to the building shall be designed to withstand wind loading in accordance with A.S 1288 or equivalent approved I.S. codes. The maximum design for the toughened glass fins for wind loading shall be as per the codes. The prevent buckling, an analysis of the fin stability is to be carried out.
- The glazing system design shall be capable of accommodating dead load and wind loads and other movements without reducing its performance or causing permanent damage.
- The dead load and the loads occurring due to wind forces acting on glazing shall be transferred to the structure / ground at its anchorage points.
- The glazing system shall be designed to withstand a minimum wind pressure in accordance with IS: 875 in that zone.
- The vertical movements occurring due to thermal expansion / contraction and structural roof members' deflection shall be accommodated as per the design of the building.
- The Glazing system shall be capable of withstanding a positive and negative pressure (100%) for 10 seconds and (1.5 x design load) for a further 10 seconds if tested in a test lab.

B1232.10 Sealants

- World Class silicone adhesive sealant having excellent properties of adhesion, elasticity, long life and of approved make shall be used. Directions of the manufacturer of the sealant shall be strictly followed.
- The contractor shall furnish details and technical information on all the above requirements.
- Contractor shall study carefully and provide report on all materials that will be in contact with the World Class silicone sealant and provide for compatibility testing and report of proper adhesion. (Adhesion with materials like glass, finished metal, surfaces, masonry, spacers etc.)
- Adhesion testing and compatibility test shall be carried out by the World Class sealant manufacturers on prototype to ensure fulfilment of values and quality required for approval prior to use with corresponding materials and surface finishes in the beginning. As it is expected that the entire materials required will be supplied in lots at regular intervals of times, the Contractor is required to state in detail how it will be ensured by them that the samples of every lot undergo the adhesion and compatibility testing meeting with the requirement of the World Class sealant manufacturer and approval.

- The Structural glazing contractor will ascertain from the manufacturer of structural silicone adhesive sealant, the sealant selection procedure and obtain their services for exercising the following controls:
- Technical and commercial support for use of silicone adhesive sealant in proposed system and details regarding properties of the silicone adhesive in respect of:
 - (i) Water absorption.
 - (ii) Resistance to water, fungi and oxidation.
 - (iii) Density and hardness.
 - (iv) Compressible stress and tensile stress.

B1232.11 Deglazing tests

B1232.11.1 Deglazing tests must be performed at the glazing contractors shop floor as per the norms of world class sealant manufacturer. Frequency of deglazing tests is one in every 50 panels.

B1232.12 Installation

Surface preparation:

Sealants may not adhere to substrates if the surface is not prepared and cleaned properly before the sealant application. Substrates should always be cleaned with solvents such as isopropyl alcohol (IPA) or xylene or methyl ethyl ketone (MEK) before the application of silicone sealant. Using proper materials as well as following prescribed surface preparation and cleaning procedures is vital for sealant adhesion.

Materials

- Use clean, fresh solvent as recommended by the structural silicone sealant manufacturer.
- Use clean, white cloths free of lint or approved wiping materials.
- Use a clean, narrow-blade putty knife.
- Use primer when required.

Surface preparation and cleaning procedures:

- Remove all loose material (such as dirt and dust), plus any oil, frost or other contaminants from the substrates where structural silicone sealant adhesion is required.
- Do not use detergent to clean the substrate as residue may be left on the surface.
- Clean the substrates receiving the sealant as follows: Using a two-rag wipe technique. Wet one rag with solvent and wipe the surface with it, then use the second rag to wipe the wet solvent from the surface BEFORE it evaporates. Allowing solvent to dry on the surface without wiping with a second cloth can negate the entire cleaning procedure because the contaminants may be re-deposited as the solvent dries.

- When cleaning deep, narrow joints, wrap the cleaning cloth around a clean, narrow-blade putty knife. This permits force to be applied to the cleaned surface.
- Clean only as much area as can be sealed in one hour. If cleaned areas are again exposed to rain or contaminants, the surface must be cleaned again.
- Change the cleaning rags frequently, as they become soiled. It is easier to see the soiling if white rags are used.

Using Solvents:

- Pour solvents from the container to the rag. Do not dip used wipe cloths into solvent as this can contaminate the solvent. Cleaning with contaminated solvent can result in sealant adhesion problems. Always use clean containers for solvent use and for solvent storage.
- Smoking, sparks, welding and flames of any type must not be permitted in the areas or the vicinity where solvents are being used. Follow all precautions on the solvent warning label & MSDS.

Primers:

- The nature of the substrate and the specific sealant formulation will determine the necessary and type of primer that may be required in a particular application. When properly used, primers help assure strong and consistent sealant adhesion to surfaces that may be difficult to bond. Most primers are a blend of organic and inorganic chemicals, resins and solvents. NEVER APPLY PRIMER TO GLASS SURFACES.
- Obtaining the proper materials, as well as following the prescribed procedures, is vital to ensure the successful use of primers.
- Primers contain solvents: Smoking, sparks, welding and flames of any type must not be permitted in the areas of the vicinity where solvents are being used. Follow all precautions on the product warning label & MSDS.

Masking:

- To simplify clean-up of excess sealant, use easy to release, pressure sensitive tap to mask adjacent surfaces before applying the structural silicone sealant.
- Start from the top down and overlap the runs. Tool in direction of overlap so that masking is not disturbed during tooling.
- Remove masking immediately after application of silicone or as soon as possible/or practical.
- Drop cloths can be used to cover any surfaces likely to collect excess sealant removed during tooling operations.

B1233 SPIDER / CLAMP FITTINGS

All spider fittings should be of SS 316 grade unless otherwise specified.

B1234 MISCELLANEOUS ITEMS

B1234.1 Stainless Steel Railings

B1234.1.1 The work shall be carried out in areas as described in the finishes schedule.

B1234.1.2 All rails and other tubular components shall be constructed using the following:

- (a) Stainless steel grade AISI, type 316; surface to be 320 grain/grit finish; tubes 1-1/2" (38mm) outside diameter by 5/64" (2 mm) wall thickness.
- (b) Balustrade material: Stainless steel SHS, grade 316
- (c) Finish: Brush finish
- (d) Dimension: 40mm square to outer
- (e) Maximum spacing: 1500mm c/c
- (f) Specific notes: Interconnecting SS 25mm SHS between top rail and baluster, SS patch fittings 4 nos. for each glass panel, SS base plates, etc.
- (g) 12mm thick Glass designer panels shall be provided with etching.

B1234.1.3 All posts and other components shall be constructed using the following:

B1234.1.4 Stainless steel grade AISI type 316, surface to be 320 grain/grit finish; posts to be 2" (50 mm) by 1/2" flat bar, finish and final design to be strictly in accordance with design guidelines.

B1234.1.5 Stainless steel grade AISI type 316, surface to be bead blasted for: component fittings including handrail attachment support and post attachment components strictly in accordance with design guidelines.

B1234.1.6 Fastening bolts to be stainless steel or other high strength material as determined by Engineering requirements

B1234.2 Fasteners for railings

B1234.2.1 Anchors shall be fabricated from stainless steel or other materials as determined by Engineering requirements with capability to sustain, without failure and rusting, load imposed within a safety factor of 4, as determined by testing per ASTM E488.

B1234.3 Fabrication

B1234.3.1 Fabricate railing system for compliance with structural requirements of applicable code. Pre-assemble railings prior to shipping to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and for coordination with shop drawings.

B1234.4 Installation

- Installation shall be by done a qualified, authorized representative of the manufacturer.
- Installation must be in accordance with standard or non-standard, yet applicable details (instructions) included on installation/shop drawings provided by the manufacturer.

- Install components plumb and in-line, accurately fitted, free from distortion or defects and securely anchored to structure.
- Provide anchors, plates, angles, etc., necessary for connecting railings to structure. Any and all field welding shall be by a certified welder,
- Access for anchors that require through-bolting, either vertically or horizontally, to be made available through General Contractor.

B1234.5 Erection tolerances

- Maximum variation from plumb shall be 1/4".
- Maximum offset from true alignment for every 50-foot of railing shall be 1/4", non-accumulative.

B1234.6 Protection after installation

- General contractor must provide protective covering on handrails and guardrails if construction is not yet finished in the area where the railings are installed.

B1234.7 Correction of deficiencies

- All deficiencies in work and/or items not meeting specified requirements shall be corrected in order to meet specification requirements at no additional cost to Employer.

B1234.8 Polished and Flamed Granite

- B1234.8.1** Providing and laying Polished and flamed best quality (as approved by the Employer) Granite stone flooring in required design and patterns, in linear as well as curvilinear portions of the building, all complete as per the architectural drawings, with 18 mm thick stone slab laid with cement based high polymer modified quickset adhesive conforming to IS:15477, in minimum 6mm thickness (as per manufactures' specification) having spacers 3mm with spacer filling with resin based epoxy grout with high degree of resistance to chemical attack, abrasion and resistance conforming to British Standards 5980:1980, including rubbing, curing and polishing etc. all complete as specified and as directed by the Employer.

B1234.9 Pantry platform in jet black (with sink & cock)

B1234.9.1 Providing and laying platform of 600mm width (clear) and at 800mm height (top) above FFL of approved 20 mm thick granite with half round nosing including moulding chamfering wherever necessary edges. It shall be supported over new low height cabinet to be provided as part of this job. But including jointing with silicon sealer. The application of ceramic tile dado of 300x600 tile up to 2' above counter over the partition wall with adhesive shall from a part of this item & shall be measured along the length of the counter. Rate shall be inclusive of making cut-outs and polishing the edges for sink. Platform shall be supported on 50mmx50mm angle irons of required quantity as per length duly painted. Rate shall include polishing of stone/grouting of tiles & internal finishing of cabinet including all necessary Kich/Godrej/Hafele fittings like 4" long stainless-steel hinges, locks, tower bolts, 100 mm stainless steel brush finished handle etc. polish of approved shade to entire satisfaction of Employer.

B1235 ANTI TERMITE TREATMENT

B1235.1 General

- The treatment shall create a chemical barrier/Zone and around the building during the construction: 6313 Part (II) 2001. Treatment shall be got done only by approved specialized agencies who shall provide guarantee of minimum 10 years against re-infestation and in the event of re-infestation shall carry our further treatment free of cost.
- Only permitted chemicals procured from authorized agencies shall be used.
- Graduated containers shall be used for dilution of chemicals and spraying shall be done by hand operated pumps.
- Adequate safety measures and protective gears shall be used while storing & handling the chemicals.
- Treatment should start when foundation trenches and pits are ready to take mass concrete foundations.
- Treatment shall not be carried out during rain or when the soil is wet.
- The treated soil barrier shall not be disturbed. If for any reason the barriers are disturbed immediate steps shall be taken to restore continuity and completeness of the barrier system.
- The applicator shall be done by fully trained and approved by the manufacturer. The manufacturer should ensure 10-year warranty for the entire roof system to the client. All installation team must obtain the training certificate from the manufacturer and also certify that the installation team is qualified to install approved roof system.
- Manufacturer should ensure the performance guarantee of the system by submitting a BG for 10% value of total work, for a period of 5 years as per special condition.

B1235.2 Chemical

The following chemicals which are effective when applied uniformly over the area to be treated shall be used in water emulsion for the soil treatment with the concentration shown against it.

Chemical	Relevant Indian Standard	Concentration by weight, percent
Imidacloprid	CIB Approved	0.075a.i. concentration i.e., 2.1ml of Imidacloprid per litre of water)

B1235.3 Treatment

B1235.3.1 The principle of the treatment is to create a continuous chemical barrier/Zone below and around the building treatment is designed depending on the type of building is described below:

B1235.4 Treatment for foundations and basement

- The bottom surface and the side (up to a height of 300mm) of the excavation made for masonry foundation and basement shall be treated with the chemical emulsion at the rate of t 5 litres per square meter surface area,
- After the masonry foundations and the retaining wall of the basements come up, the backfilling immediate contact with the foundation structure shall be treated at the rate of 7.5 litres per square meter of the vertical surface of the sub-structure for each side.
- The earth is usually returned in layer and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the masonry surface so that the earth in contact with these surfaces is well treated with the chemical.

B1235.5 Treatment of RCC Foundation and basement

B1235.5.1 The RCC foundation require to be completely enveloped by a chemical barrier. In RCC Foundation the concrete is dense being a 1:2:4 mix or richer, the termites are unable to penetrate it. It is therefore unnecessary to start the treatment from the bottom of excavation. The treatment shall start at a depth of 500 mm below the ground level. From this depth, the backfill soil in immediate contact with vertical surfaces of RCC Foundations shall be treated at the rate of 7.5 liters per square meter.

B1235.6 Treatment of top surface of plinth filling

B1235.6.1 The top surface of the consolidated earth within plinth wall shall be treated with chemical emulsion at the rate of 5 liters per square meter of the surface before the sand-bed or sub - grade is laid. If the filled earth has been well rammed and surface does not allow the emulsion to seep through, holes up 50 to 75 mm deep at 150 mm centers both ways may be made with 12 mm diameter mild steel rod on the surface to When pipes, wastes and conduits enter the soil inside the area of the foundation, the soil with the chemical emulsion.

B1235.7 Treatment at junction of the Wall and the floor

B1235.7.1 Special care shall be taken to establish continuity of the vertical chemical barrier/zone of inner wall surface from ground level up to the level of filled earth surface. To achieve this a small channel 30mm x 30mm shall be made at the junction of wall and columns with the floor (before laying the sub-grade) and rod holes made in the channel up to the ground level 150 mm apart and the rod moved backward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 liters per square meter of the vertical wall or column surface so as to soak the soil right to the bottom. The soil should be tamped back into place after this operation.

B1235.8 Treatment of Soil along External Perimeter of Building

B1235.8.1 After the building is complete, the earth along the external perimeter of the building should be rodded at intervals of 150 mm and to a depth of 300 mm. The rods should be moved backward and forward, parallel to the wall to break up the earth and emulsion poured along the wall at the rate of 7.5 liter per square meter of vertical surfaces. After the treatment, the earth should be tamped back into place. Should the earth outside the building be graded on completion of building, this treatment should be carried out on the completion of such grading. In the event of filling more than 300 mm, the external perimeter treatment shall extend to the full depth of filling up to the ground level so as to ensure continuity of the chemical barrier/Zone.

B1235.9 Treatment of Soil under Apron along External Perimeter of Building

B1235.9.1 Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 liters per square meter of the surface before the apron is laid. If consolidated earth does not all emulsion to seep through, holes up to 50 to 75 mm deep and 150 mm centers both ways may be made with 12 mm diameter mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

B1235.10 Treatment for Walls Retaining Soil above Floor Level

B1235.10.1 Retaining walls like the basement walls or outer walls above floor level retaining soil need to be protected by providing chemical barrier / zone by treatment of retained soil in the immediate vicinity of the wall so as to prevent entry of termites through the voids in masonry cracks and crevices etc., above the floor level .The soil retained shall be treated at the rate of 7.5 mm per square meter of the vertical surface so as to effect a continuous outer chemical barrier /zone.

B1235.11 Treatment of Soil Surrounding Pipes, Wastes and Conduits

B1235.11.1 When pipes, wastes and conduits enter the soil inside the area of the foundation, soil surrounding the point of entry shall be loosened around each of such pipe, waste or conduits for a distance of 150 mm and up to a depth of 75 mm before the treatment is commenced. When they enter the soil external to the foundation, they shall be similarly treatment for a distance of 300 mm, unless they stand clear of the walls of the building by about 75 mm.

B1235.12 Treatment for Expansion Joints

B1235.12.1 Expansion joints at ground floor level are one of the biggest hazards for termite infestation. The soil beneath these joints should receive special attention when the treatment under 3.3 is carried out. This treatment should be supplemented by treating through the expansion joint after the sub- grade has been laid, at the rate of 2 liters per linear meter.

B1235.13 Precautions to be taken

- Treatment should not be carried out when it is raining or when the soil is saturated with sub-soil water. The chemical shall be applied to soil when the soil is dry and absorbent. Immediate steps to be taken by the customer to cover the treated layer by laying soiling /PCC etc.
- Once formed treated soil barriers zone must not be disturbed. In case treated soil is disturbed, immediately steps shall be taken to restore the continuity and completeness of barrier system at an additional cost to the customer.

B1236 TACTILE FLOORING

B1236.1 Providing and laying tactile tile (for vision impaired persons as per standards) of size 300x300x14.5 to 15mm having water absorption less than 0.5% and conforming to IS: 15622, of approved make in all colours and shades in outdoor floors such as footpath, court yard, etc., laid on 20mm thick base of cement mortar 1:4 (1 cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. complete as per direction of Employer.

B1236.2 Surface quality

B1236.2.1 Minimum 95% of tiles shall be free from visible defects that would impair the appearance of a major area of tiles.

B1236.3 Dimensions and Tolerances

B1236.3.1 The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

B1236.3.2 Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with joints matching the pattern of floor tiles) match with dimensions of full tiles.

B1236.3.3 Preparation of Surface and laying.

B1236.3.4 All new substrata shall be allowed to cure and dry completely according to standard practice. The base should be hard and strong and free from random cracking and potholes.

B1236.3.5 Adhesive must be applied to the prepared surface using a Notch trowel. It is important to spread the right quantity of adhesive for good Adhesion to the slab.

B1236.3.6 For large area flooring leave Expansion and contraction joint between tiles to prevent cracks.

B1236.3.7 Before fixing tactile tiles lay them out in the desired pattern and make sure that they give an acceptable blend of colour.

B1236.3.8 The work size will be as per ISO specifications. As part of internationally accepted laying practices.

B1236.3.9 Complete the tiles laying process by pressing the cut tiles firmly into place along the walls/floors. Allow a minimum of 48 hours for bed curing. After this period fill the joints with grouts with recommended joints. Usage of grout sealant is recommended for keeping the grout free of dust.

B1236.3.10 15 minutes after finishing the grouting process, wipe off excess grout with a damp sponge and polish the tiles with a soft and dry cloth for a clean surface as directed by Employer.

B1236.3.11 The finished surface shall be protected properly using 5 mm thick tile protection sheet till handing over the site.

B1236.4 Technical Characteristics

- Fully vitrified unglazed porcelain tile
- Low water absorption, below 0.5 %
- Approved profiled tactile design
- Approved size =30 cm x 30 cm x1.5 cm
- Tac button profile =1 cm +0.45 cm
- Tac liner profile =1 cm+0.45 cm
- Corundum addition for mohs hardness >7
- Excellent slip resistance
- Very dense, durable, abrasive resistance
- Solid through colour-fade proof

- High chemical and stain resistance

Test

All tests to be conducted as per IS 4457:2007

Material	Test	Field/ Laboratory test	Test Proce dure	Min. qty of material for carrying out the test	Frequency of test
Tactile tiles	1.Dimension ns and surface quality 2.Physical properties 3.Chemical properties	Laboratory	IS: 4457:2 007	300 nos	One test for every 300 Nos. or part thereof for each type and size from a single manufacturer. (One test to be done even if the number tiles of any type and size from a single manufacturer is less than 150 Nos. provided the total number of tiles of all types and sizes from all manufacturers used in a work exceed 150 Nos.

Acceptance Criteria

For tactile tile

S. No.	Property	Standard Laid Down
1.	Deviation in Length and width	± 0.6%
2.	Deviation in Thickness	± 5%
3.	Deviation Straightness of side	± 0. 4%
4.	Deviation Rectangularity	± 0.5%
5.	Deviation Surface Flatness	± 0.3%
6.	Water absorption	≤0.5%
7.	Mohs Hardness	≥7
8.	Breaking strength	≥4000N
9.	Abrasion Resistance	<144 mm ³
10.	Skid Resistance	>0.6

S. No.	Property	Standard Laid Down
11.	Flexural strength (Average MOR)	>38N/mm ²
12.	Density (G/CC)	>2.2gm/cc, min
13.	Moisture Expansion	Nil
14.	Resistance to conc. Acid (wt. loss)	≤1%
15.	Resistance to household chemicals and swimming pool salts	Resistance
16.	Stain Resistance	Resistance
17.	Thermal Expansion	<9 x 10 ⁻⁶ K ⁻¹
18	Thermal shock resistance	No damage

Document to support acceptance criteria should be submitted along with materials delivered at site.

B1237 RAIN WATER GUTTER

B1237.1 Supply and installation of rain water gutter at roof level as per drawing, using 1mm thick SS 304 grade Stainless steel sheets including finishing joints with tig argon welding as approved by the Employer. The gutter shall be supported on MS brackets. Gutter shall receive the downspouts at designed intervals and all joints with downspouts should be welded and made water tight. Gutter shall be fixed in lines and levels complete as directed by the Employer at all levels.

B1238 ROLLING SHUTTERS

B1238.1 General

B1238.1.1 Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e., outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with mechanical device supplied by the firm. Shutters upto 10 sq. meter shall be of push and pull type and shutters with an area of over 10 sq. meter shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

B1238.2 Shutter

B1238.2.1 The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90 mm for the shutters upto 3.5 m width. Shutters above 9 meters width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the center with a bridge depth of not less than 12mm to provide sufficient curtain of stiffness

for resisting manual pressures and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

B1238.3 Spring

B1238.3.1 The spring shall be of coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454- Part I.

B1238.4 Roller and Brackets

B1238.4.1 The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161. For shutter upto 6 meter width and height not exceeding 5m, steel pipes of 50mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x 3.15 mm for shutters upto a clear height of 3.5m. The size of mild steel brackets shall be 500x500x10mm for shutters of clear height above 3.5m and up to 6.5m. The suspension shaft clamped to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

B1238.4.2 When the width of the opening is greater than 3.5mtr. The cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32x6mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self-aligning two row ball bearing with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15mm and at least 4 number flats running throughout length of roller shall be provided.

B1238.4.3 In case of shutters of large opening with mechanical device for opening the shutter, the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

B1238.5 Guide Channel

B1238.5.1 The width of guide channel shall be 25mm the minimum depth of guide channels shall be as follows:

Clear width of shutters	Depth of guide channel
Up to 3.5 m	65 mm
3.5 m up to 8 m	75 mm
8 m and above	100 mm

B1238.5.2 The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

- B1238.5.3 Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.
- B1238.5.4 The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.
- B1238.6 **Cover**
- B1238.6.1 Top cover shall be of mild steel sheets not less than 0.90 mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.
- B1238.6.2 Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.
- B1238.7 **Ball bearing**
- B1238.7.1 Ball bearing shall be as per IS 2898
- B1238.8 **Fixing**
- B1238.8.1 The arrangement for fixing in different situations in the opening shall be as per IS 6248.
- B1239 ROLLING GRILL SHUTTERS**
- B1239.1 **General**
- B1239.1.1 Rolling grill shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter. The situations where a certain amount of ventilation combined with safety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rolling grill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter. The total height of the grill portion in all the segments of rolling shutter-cum-grill shall not exceed 1.0m and the height of the grill portion in any individual segment shall not be more than 0.5m.
- B1239.1.2 Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 10.8 shall be applicable to rolling grills shutters except in respect of the shutter portion and shall conform to IS 6248.

B1239.2 Shutters

B1239.2.1 Rolling grill shutter and the rolling grill portion of the rolling shutter-cum-grill shall be fabricated with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20 mm wide and 5 mm thick mild steel flat links. Straight bars shall be spaced not exceeding 150 mm center to center and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Unless otherwise specified or directed by the Employer, bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 100 to 120 mm and the depth of corrugation is 80 to 100 mm. all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes and the length of the links shall be such that the distance from the center of the hole to the nearest edge of the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All links shall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as center to center distance between two consecutive crests/troughs of the bars bent to the required profile. Each bar and link shall be continuous single piece without any joint

B1240 EXTERIOR PAINT

B1240.1 Finishing walls with, heat resistant, washable, stain free, weather proof acrylic smooth exterior paint for new work (Two or more coat applied @1.67 ltr/10sq.m emulsion over and including priming coat of exterior primer applied @ 2.20kg/ 10sqm complete as directed by the Employer at all levels.

B1240.2 This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Employer. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Employer.

B1240.3 For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Employer after inspection before painting is commenced.

B1240.4 Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Employer shall be followed meticulously.

B1240.5 The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

B1241 GRANITE STONE FLOORING

B1241.1 The granite has to be processed by water cut method and shall be machine polished using Auto polisher or line polisher to mirror finish to have a gloss meter reading of 90 above.

B1241.2 The stone shall be of approved quality, size and uniform thickness and shall be hard, sound, dense and homogenous in texture. It shall be uniform in shade free from stains, cracks, decay and weathering.

B1241.3 The edges are machine cut to fine, straight, with square edges and free from chippings. Stone should be laid on a bed of cement mortar as specified in item specifications. Thickness of mortar bedding shall be specified in the item specifications and a neat cement shall be spread over the motor bed and the slab/tiles shall be placed one by one, keeping in check the level and line of the flooring. Tiles are wetted before placing. The tiles are then gently tapped with wooden mallet till it is firmly and properly bedded. There should be no voids left. The joint should be paper joint. The pattern of the flooring shall be as per the architectural drawings or as directed by Employer.

B1241.4 The base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, batted and mopped. The minimum thickness of bed mortar shall not be less than 12 mm. Any undulation in the base concrete or RCC slab shall be corrected by cement mortar without any extra cost and any additional leveling required beyond max. mortar thickness to be carried out with cement concrete.

B1241.5 The flooring shall be cured for a minimum period of 7 days. The surface of the flooring shall be laid to levels and slopes as directed by Employer.

B1241.6 Due care shall be taken to match the grains of tiles which shall be selected judiciously having uniform pattern.

B1241.7 The tiles which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the skirting or dado. The junction between the wall plaster and the floor shall be finished neatly and without waviness.

B1241.8 The free edges shall be cut as per the pattern and shall be polished to match with flooring.

B1241.9 Before starting the work, the contractor shall generally get samples of granite tiles polished to the satisfactory level for approval of Employer and shall be kept in the custody of the Employer and the tiles/slabs supplied and used on the work shall confirm to the samples with regard to soundness, colour, shades, general texture and finishing/polishing.

B1241.10 Employer has liberty to ask for any tests with respect to physical properties, level of polishing, etc. and the contractor shall arrange the same without any extra cost.

B1241.11 Granite slabs in steps

B1241.11.1 It shall be of single piece and type/size shall be to match the sizes of the treads/risers. The edges shall be machine cut to the required shape.

B1242 POLYCARBONATE ROOFING SHEET

B1242.1 Providing & fixing Poly carbonate multi wall plain sheet 8 mm thick as approved by the Employer and should be supplied in a single length of 12 M or as decide by the Employer. The sheets shall be fixed using self-drilling/self-tapping screw of size (5.5x55mm) with EPDM seal complete upto any pitch in horizontal /vertical / curved surface, but excluding the cost of purlins, rafters, trusses, and including cutting to size and shapes where ever required.

B1242.2 Materials

- (a) Polycarbonate sheets are transparent like glass and are available as clear and colour (Blue, bronze/green) sheets in thickness ranging from 1 mm to 8 mm.
- (b) They come in variety of profiles - compact, embossed, multiwall or corrugated.
- (c) They shall conform to specifications detailed in IS: 14443.
- (d) The sheets shall be UV stabilized and shall be tested for accelerated weathering conforming to ISO 4892.
- (e) The guaranteed service life of the polycarbonate sheets shall be a minimum 10 years covering discoloration (yellowing), loss of light transmission, and loss of strength due to weathering.

B1242.3 Laying and fixing

B1242.3.1 Fabrication practices for polycarbonate sheets are detailed under Annexure A of IS: 14443.

B1242.4 Material Properties

Properties	Test code / ACCEPTANCE LEVEL
Weathering	ASTM D4364-84
Light Transmission	ASTM D1003
Water Penetration	ASTM E-331
Air Infiltration	ASTM E-283
Impact	ASTM E-822-81

B1243 FALSE FLOORING

B1243.1 General: Providing and fixing raised floor system as per below mentioned specification

B1243.2 PANELS: 35mm Thick Access Floor panel of size 600 x 600 mm shall be all steel welded construction with an enclosed bottom pan of hemispherical cones and the top plain sheet is fuse-welded at 144 locations to form a panel. The hollow panels post manufacturing shall be pre-treated on an Automated Pre-treatment line and further coated with electrostatically deposited epoxy raisin paint 60 - 80 micron thick on all the exposed sides of the panel. Post-coating the hollow core of the panel is injected with a lightweight, fire retardant, non-combustible cementitious compound at high pressure to ensure support of not less than 90% of the top surface area of the panel. The panel is then laminated with floor grade Antistatic Laminate on a semi-automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated panel should be an Integral trim without beeding.

B1243.3 **PANEL DESIGN REQUIREMENT:**

- The Panel should have a Low Flange Width of 8.00mm on all four sides
 - Providing a higher strength to the unsupported edge thus leading to reduced risks and minimalistic damage due to frequent access to the panel post installation
 - Enabling the panel to perform better on all technical parameters & with enhanced load-bearing capacity
 - Reducing risk of accidents at site, due to less exposed area while stacking the material at site
- Beam width of the panel should be 19.50mm
 - Enhances load-bearing capacity by ensuring full support on the entire perimeter, through the beam of the panel when used with the ESRG system
- The panel resting on the pedestal head should have a minimum footprint area of not less than 730.355 sq. mm.
 - Higher footprint area of the panel on the pedestal head enhances the load-bearing capacity of the panel, proving an increased support to the panel
- Corner Radius of the panel should be R 15.00mm & with reduced cantilever flange edge of 19.60mm.
 - Panel with lower radius, improves reducing the exposed cantilever edge on the unsupported areas at the corners of the panel.
- LEED/Green Certified product.
 - All panels to have a recycle content of minimum 30%.
 - The panels should be Green certified by a Green building council authority.

- B1243.3.1 **SUB STRUCTURE -PEDESTAL ASSEMBLY:** Substructure installed to support the panel shall be suitable to achieve a minimum finished floor height of 150 mm to a maximum of 2000 mm from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of levelling and accurately align panels for a maximum ± 25 mm in the vertical direction. Pedestals shall support an axial load without permanent deflection and an ultimate load as laid out in System Performance requirement.
- B1243.3.2 The Pedestal head assembly shall consist of embossed head mechanically riveted to a rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-vibrational conductive cap with inbuilt isolating spacers for Panel and stringer location.
- B1243.3.3 The Pedestal Base assembly shall consist of pipe mechanically locked on a press for perpendicularity and then mechanically welded to a base plate with stiffening folds for enhanced strength & excellent grip to glue.
- B1243.3.4 The substructure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the consultant/manufacturer. All steel components shall be Hot Dip Galvanized.
- B1243.3.5 **STRINGERS:** The stringer shall be Continuous Box type, hot dipped galvanized steel cold rolled construction for strength, lateral stability, and for enhanced rolling loads performance and to support the panels on all four sides for alignment without leaving any gap at the pedestal head preventing air leakage. The stringer to have countersunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly.

PERFORMANCE CONFORMING TO MASTER SPECS 10270 / 096900 (USA)

A: Structural Performance: CISCA A/F, 'Recommended Test Procedures for Access Floors'

Concentrated Loads: 360 Kgs (800 lbf) with a top-surface deflection under load and a permanent set not to exceed 2.54 & 0.25 mm (0.10 & 0.010 inches) respectively according to CISCA A/F, Section I " Concentrated Loads"

Ultimate Concentrated Load: 900 kgs (2000 lbf) without failing according to CISCA A/F, Section II " Ultimate Loading"

Uniformly Distributed Load (UDL) : 1650 kg/m² with a maximum permissible deflection of not more than 2.5 mm as per definition of "Uniform load" of CISCA.

Pedestal Axial Load Test : 22 kN axial Load per pedestal, according to CISCA A/F, Section V, "Pedestal Axial Load Test"

Pedestal Over Turning Moment Test: 113 N x meters, according to CISCA A/F, Section VI, "Pedestal Overturning Moment Test"

Rolling Loads :180 kgs (400 lbf) of the following magnitude, with a combination of local and overall deformation not to exceed 1.02 mm (0.040 inches) according to CISCA A/F, Section III “ Rolling Loads”

CISCA AF Rolling Load: 10000 Passes

B: Other Optional Structural Parameters:

Soft body impact test on the system shall be with a load of 40 kgs dropped from a height of 1000 mm and shall comply to all the performance as specified in the test method (T12.03) of MOB PF2 PS Standards.

Hard body impact test on the system shall be with 4.5 kgs dropped from a height of 600 mm and shall comply to all the performance as specified in the test method (T13.03) of MOB PF2 PS Standards.

C: Other Non-structural Parameters:

Fire Rating: The Panels shall confirm to Class O & Class 1 Fire Ratings tested as per BS 476 Part 6 (Fire Propagation) & 7 (Surface spread of flame) as also ASTM E84 1998 (Flammability) and ASTM E136 (Combustibility)

Electrical Resistivity: As per ASTM F150/ NFPA 99 / ANSI S7.1 / CEI 61340 but modified for the surface to ground. To place one electrode on the Access floor Panel surface and to attach the other electrode on the pedestal.

Resistance to be tested at 100/500 volts

1. Conductive range: $2.5 \times 10^4 - 1 \times 10^6$ Ohms/Kv (surface to ground)
2. Static dissipative range: $1 \times 10^6 - 1 \times 10^9$ Ohms/Kv (surface to ground)
3. Anti-static range: $1 \times 10^9 - 2 \times 10^{10}$ Ohms/Kv (surface to surface)

Fabrication Tolerance:

- A. Floor panel flatness ± 0.75 mm in any direction
- B. Floor panel width or length from specified size ± 0.50 mm
- C. Floor panel squareness ± 0.38 mm

Installation Tolerance: A. Overall level before application of any load ± 1.5 mm over any 5.00 Sqm (or) ± 6 mm over any size of basic space.

D. Panel level - + 0.75 mm before the application of any load

E. Panel Interchangeability installation and removal shall be interchangeable (except for field cut panels) and replaceable in any of the four directions at 90° increments

Sub structure - pedestal assembly installed to support the panel shall be suitable to achieve a minimum finished floor height as follows

Grommets: Provide and install 75 mm dia. Heavy Gauge PVC grommets with rotating cover and passage for cables in pre-cut openings. The edges of the openings to be properly polished to prevent any injuries

B1244 UPVC WINDOWS

- B1244.1 Providing and fixing of openable or fixed type windows fabricated using UPVC reinforced profiles of NCL, Fenesta, Vega or equivalent (test report of CIPET to be produced) of approximate thickness 1.6-2.2mm for outer frame, shutter frames and mullions .The dimensions of the frame profile shall be approximately 60 x 55mm, sash profile shall be approximately 75 x 60 mm, mullion profile shall be approximately 74 x 60 mm . The frame/ mullion profiles and sash profiles shall be reinforced with profiles made of G.I. sheet and are of dimensions approximately 28 x 20 x 1.6 mm and 23 x 31 x 1.6 mm respectively. Each openable shutter shall be provided with SS304 grade Espagnollete multi point locking, Aluminium powder coated handle and friction stays of SS 304 grade for openable shutters. The window system is to be installed at the site using 80mm long electroplated screws with expandable nylon plugs. The windows shall be provided with 6mm toughened glass as per the requirement of the site Employer and including cost and conveyance of all materials, accessories, labour charges for transportation, erection at site complete for finished item of work.(Note: The frame, sash, mullion and reinforcing profile dimension shall be as per the above specification or in nearest available size approved by the Employer.)
- B1244.2 All the hardware like friction stays, handles should be screwed with self-tapping screws. The handles, locks should be designed so that they cannot be released from outside. The profiles should be cut to length and welded 45 degrees. The window should be designed such that the water does not pass through the reinforcement chamber. The window system should be fixed directly to the plastered brick wall using self-expanding nylon plug and driving MS electroplated screws into plug. The window system should be glazed with 12mm clear toughened glass and UPVC louver system as per approved drawing.

B1245 SHOT BLASTED RIBBED PAVER BLOCKS

- B1245.1 Shot blasted antiskid ribbed pavers shall be provided in the entrance and ramp areas and jointed with neat cement slurry mixed with pigment to match the shade of pavers, including rubbing and cleaning etc. complete, laid on 20 mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand) over a PCC bed 1:4:8 of 100mm thk.

B1246 MANGALORE TILES

B1246.1 General

- B1246.1.1 The roofing tiles shall be made from suitable clay of even texture and shall be well burnt. They shall be free from irregularities, such as twists, bends, cracks and laminations. The roofing tile shall be free from impurities like particles of stone, lime or other foreign materials visible to the naked eye either on the surface or on the fractured face of the tile obtained by breaking the tile. However, occasional particles up to 2 mm in size may be permissible. When struck, the tile shall give a characteristic ringing sound and when broken the fracture shall be clean and sharp at the edges. The tile shall be of uniform colour.

All the tests shall be conducted in accordance with IS 654.

B1247 ALUMINIUM COMPOSITE PANEL CLADDING

B1247.1 General

B1247.1.1 Designing, fabricating, testing, installing and fixing in position Curtain Wall with Aluminium Composite Panel Cladding, with grooves for linear as well as curvilinear portions of the building, for all heights and all levels etc. including:

- (a) Structural analysis & design and preparation of shop drawings for pressure equalisation or rain screen principle as required, proper drainage of water to make it watertight including checking of all the structural and functional design.
- (b) Providing, fabricating and supplying and fixing panels of aluminium composite panel cladding in pan shape in metallic colour of approved shades made out of 4mm thick aluminium composite panel material consisting of 3mm thick FR grade mineral core sandwiched between two Aluminium sheets (each 0.5mm thick).The aluminium composite panel cladding sheet shall be coil coated, with Kynar 500 based PVDF / Lumiflon based fluoropolymer resin coating of approved colour and shade on face # 1 and polymer (Service) coating on face # 2 as specified using stainless steel screws, nuts, bolts, washers, cleats, weather silicone sealant, backer rods etc.
- (c) The fastening brackets of Aluminium alloy 6005 T5 / MS with Hot Dip Galvanised with serrations and serrated washers to arrest the wind load movement, fasteners, SS 316 Pins and anchor bolts of approved make in SS 316, Nylon separators to prevent bi-metallic contacts all complete required to perform as per specification and drawing The item includes cost of all material & labour component, the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory, field tests on the assembled working curtain wall with aluminium composite panel cladding, cleaning and protection of the curtain wall with aluminium composite panel cladding till the handing over of the building for occupation. Base frame work for ACP cladding is payable under the relevant aluminium items. The Contractor shall provide curtain wall with aluminium composite panel cladding, having all the performance characteristics all complete, as per the Architectural drawings, as per item description, as specified, as per the approved shop drawings and as directed by the Employer. However, for the purpose of payment, only the actual area on the external face of the curtain wall with Aluminium Composite Panel Cladding (including width of groove) shall be measured in sqm. up to two decimal places."

B1248 VACUUM DEWATERED FLOORING

B1248.1 General

B1248.1.1 This specification defines the material, mixing, placing, curing, constructional and other performance requirements for Vacuum Dewatering Concrete System for concrete floor slab. Any other special requirements shown or noted on the drawings and directed by the Employer shall govern over the provision of this specification. Actual work shall be carried out in accordance with this specification and in consultation with specialized firm undertaking the job to suit specific requirement at site such as rise and fall of the floor slab, providing dowels for pedestals etc. In case of conflict between clauses mentioned in this specification and those in any Indian Standard, this specification shall govern.

B1248.2 Material

B1248.2.1 Minimum grade of concrete used shall be M30 conforming to IS-456. Only Design Mix Concrete shall be used. For other details like proportioning, batching, mixing, placing, curing etc.

B1248.3 Concrete Laying

B1248.3.1 Concrete laying pattern shall be decided in consultation with the Employer and with his approval. The maximum width of a slab strip shall not generally exceed 4 meters and minimum number of construction joints shall be used. Alternate slab strips shall be sequentially laid. Any damage to the already finished top surface shall be avoided. At construction joints no overflow of mortar or slurry on the already hardened surface shall be allowed while concreting the intermediate slab strip. Such construction joints shall be marked with a thread in a straight line while the concrete is still green. Continuity of reinforcement shall be maintained while laying concrete in slab strips. Edges at expansion joints shall be protected and proper arrangement of shear-transfer shall be provided standards.

B1248.3.2 After placing concrete in position, it shall be vibrated thoroughly using poker/needle vibrators and thereafter leveled with surface vibrators to produce a homogeneous and smooth concrete surface. In order to achieve a smooth surface to the satisfaction of the Employer, surface vibrators shall be very carefully used by skilled operators. Over vibration resulting in excess mortar near the surface shall be avoided.

B1248.3.3 Suction mats shall be spread over the levelled fresh concrete surface and shall be connected by suction hose to the vacuum pumps for De-watering of surplus water in the concrete. During De-watering it shall be ensured that no cement/cement slurry is pumped out.

B1248.3.4 This shall be done after De-watering by using skim floater (power floater). After this, surface shall be troweled with minimum two passes of power trowel to achieve a wear resistant surface to the satisfaction of the Employer.

B1248.3.5 However, all care shall be taken to avoid any stain any permanent stain on the surface. Any stain or permanent marking on the top surface shall be removed by approved means.

B1248.3.6 The Contractor shall arrange all approaches, scaffolding, working platforms etc. for carrying out the entire operation safely and in a work-man-like manner. The working area shall be nearly maintained and all the facilities required by the Employer for proper supervision of the work shall be provided.

B1249 SHOT BLASTED RIBBED PAVER BLOCKS

B1249.1 Shot blasted antiskid ribbed pavers shall be provided in the entrance and ramp areas and jointed with neat cement slurry mixed with pigment to match the shade of pavers, including rubbing and cleaning etc. complete, laid on 20 mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand) over a PCC bed 1:4:8 of 100mm thk.

B1250 SANDWICH ROCKWOOL PANELLED ROOFING

B1250.1 General

B1250.1.1 These technical specifications describe out the features of the mineral wool used as insulating layer in flat or corrugated sandwich panels in rock wool with particular fire resistance features.

B1250.1.2 Supply and fixing of sandwich rockwool paneled roof in 80mm thick made out of 0.50mm TCT colour coated aluminium sheets of approved colour.

B1250.2 Profile

B1250.2.1 34.5mm crest height in 333.3mm pitch on the top and 0.50mm TCT colour coated aluminium slightly ribbed sheet at the bottom with rockwool insulation as infill.

B1250.3 Colour

B1250.3.1 The colour coating on sheet shall have a total coating thickness of 35 micron comprising of 20 micron Silicon Modified Polyester Paint system of approved colour on the top and 5 microns back up epoxy coating at the bottom over 5 micron primer coating on both sides.

B1250.4 Material

Steel

Thickness – BMT / TCT 0.5mm, 0.6mm, 0.8mm

Paint coating - Polyester based paint

Polyester primer – 5 microns standard colour

RMP coating/ SMP coating/ PVDF coating-20microns

as per RAL colour system

Back coat – 5 microns standard colour grey

Resistance to saline mist >/ 500 h

Resistance to moisture >/ 1000 h

B1250.5 Material Properties

B1250.6 Density

B1250.6.1 Density of roof material shall be determined according to UNI 6485 and shall give a minimum density of $100 \pm 8 \text{ kg/m}^3$.

B1250.7 Loss to fire

B1250.7.1 Loss to fire shall be determined according to UNI 10522 and shall be $3.5 \pm 0.5 \%$

B1250.8 Size stability at high temperatures

B1250.8.1 The panels shall have the dimensional / size stability at high temperatures up to 2 hrs.

B1250.9 Compression

B1250.9.1 Resistance to compression shall be determined according to regulation EN 826. The minimum reference values for the given density are as follows:

Axis x (yield load) $R_c=40 \text{ kPa}= 0.040 \text{ N/mm}^2$

Axis y (load at 10% of deform.) $R_c=15 \text{ kPa}= 0.015 \text{ N/mm}^2$

Axis z (yield load) $R_c=60 \text{ kPa}= 0.060 \text{ N/mm}^2$

Young's Modulus

Axis x $E= 2000 \text{ kPa} = 2 \text{ N/mm}^2$

Axis y $E= 150 \text{ kPa}= 0,15 \text{ N/mm}^2$

Axis z $E= 4000 \text{ kPa} = 4 \text{ N/mm}^2$

B1250.10 Percentage of infibrato

B1250.10.1 The content of infibrato material will be determined according to the indications of the regulation ASTM-C-612. The following percentages of infibrato must not exceed.

with 250 mm sieve 5 %

with 63 mm sieve 25 %

B1250.11 Thermal dynamic features

B1250.11.1 The thermal conductivity of the material must be measured along the fibre, thus taking into account the exact orientation of the final sandwich. The ASTM C-518 method is used. The test temperatures must be 10 and 36°C respectively for the cold and hot plates. They must have the following values.

Minimum density – 100 kg/m³

0.045 W/m °C 0.043 W/m °C

B1250.12 Chemical compositions

B1250.12.1 The panel shall not contain lead, crystalline silica or asbestos fibre in any form. In addition, the material must correspond to the requirements of bio-solubility as indicated in Note Q of European Directive 97/69/EC set out in the M.D. dated 1.9.1998, of the Health Ministry.

B1250.13 Installation of roof panels

- (a) Sandwich panels are fixed with tongue and groove method.
- (b) Roof panels shall be continuous from ridge to eave for buildings, where end laps are required, the width shall be approximately 150 mm and shall occur over a roof purlin.
- (c) All laps of roof panels shall be sealed with a continuous ribbon of tape sealer.
- (d) Roof panels shall be secured to intermediate framing members metal screws at a maximum spacing of 333 mm. At end laps, the maximum spacing of screws shall be 111 mm.
- (e) Side laps of roof panels shall be stitched through the high rib with two, equally spaced metal screws between supports (screw spacing not to exceed 525 mm).

B1300 ROAD WORKS

B1301 CONTROL OF TRAFFIC

- B1301.1 The Contractor shall take all necessary precautions in co-ordination with and to the requirements of all the competent authorities concerned to protect the work from damage until such time as the seal coat or surface treatment has developed sufficient strength to carry normal traffic without any damage to it.
- B1301.2 The new work shall be opened to traffic only after it is authorized by the Employer. The Contractor shall submit a detailed traffic diversion/or control and regulation plan taking all safety measures during the course of work permitted by the concerned authorities to the Employer for his consent before start of work.
- B1301.3 The Contractor shall take all precautions to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or side tracks are available, traffic shall be temporarily diverted while the work is in progress depending on volume of traffic and subject to approval by Kerala Traffic Police. Adequate signs, signals, barriers and lamps for the warning and guidance of traffic shall be provided at all times during the course of the work till it is opened to traffic.
- B1301.4 The Contractor shall take all reasonable precautions to protect traffic against accident, damage or disfigurement by construction equipment, tools, and materials, splashes and smirches of bitumen/bituminous material or any other construction materials and shall be responsible for any claims arising from such damage or disfigurement.
- B1301.5 Traffic signs erected shall be in accordance with the IRC & MORTH Standards and/or as prescribed and approved by the Kerala Traffic Police Department.

B1302 GRANULAR SUB-BASE

- B1302.1 This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these specifications or as per IRC & MORTH standards, as acceptable to Highway authorities. The material shall be laid in one or more layers according to lines, grades and cross-sections shown on the approved drawings or as directed by the Employer.
- B1302.2 **Material**
- B1302.2.1 The Material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading specified in IRC/MORTH specifications for Roads and Bridges. The material shall be free from organic or other deleterious constituents.

B1302.3 Physical requirements

B1302.3.1 The material shall have a 10 percent fines 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 by 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. CBR Value 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 percent.

B1302.4 Strength of sub-base

B1302.4.1 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.

B1302.5 Construction Operations

I. Preparation of sub-grade

Immediately prior to the laying of sub-base, the sub-grade already finished as per MORTH Clause 301 or 305 as applicable or existing surface 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. Damage to the subgrade shall be made good before sub base is laid.

II. Spreading and compacting

B1302.6 The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor 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 Employer.

B1302.7 When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix-in-place method.

B1302.8 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 Employer, trial runs with the equipment shall be carried out to establish its suitability for the work.

- B1302.9 Moisture content of the 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 Employer so that, at the time of compaction, it is from 1 percent above to 2 percent 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, rotavators until the layer is uniformly wet.
- B1302.10 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 a vibratory roller of minimum 80 to 100 KN static weight with plain drum or pad foot-drum or heavy pneumatic tyre roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 MN/m² 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 and super-elevation and shall commence the center at the edges and progress towards for portions having cross fall on both sides.
- B1302.11 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.
- B1302.12 Rolling shall be continued till the density achieved is at least 98 percent 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.
- B1302.13 **Control of Traffic**
- B1302.13.1 Control of traffic shall be as described under Subsection 16.1
- B1303 WET MIX MACADAM(WMM)**
- B1303.1 **Description**
- B1303.1.1 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 subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications or as per IRC & MORTH standards, as acceptable to Highway authorities. 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 Employer.

B1303.2 Materials

B1303.2.1 Physical requirements: Course aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 16.3.1 below.

Table:16.3.1

Physical requirements of coarse aggregates for wet mix macadam for sub-base/base course

S. No.	Test	Test Method	Requirements
1.	Los Angeles Abrasion Value	IS: 2386 (Part-4)	40 Percent (Max)
2	Aggregate Impact value	IS: 2386 (Part-4) or IS: 5640	30 Percent (Max.)
3	Combined Flakiness and Elongation indices (Total)	IS: 2386 (Part-1)	30 Percent (Max.)

Note: - Aggregate may satisfy requirements of either of the two tests.

B1303.2.2 To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

B1303.2.3 If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part-5).

B1303.2.4 Grading requirements: The aggregates shall conform to the grading given in following Table 16.3.2

Table 16.3.2

IS Sieve Designation	Percent 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
4.75	mm	25-40
2.36	mm	15-30
600.00	micron	8-22
75.55	micron	0-5

B1303.2.5 Materials finer than 425 microns shall have Plasticity Index (PI) not exceeding 6.

B1303.2.6 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.

B1303.3 Construction Operations

B1303.3.1 Preparation of base: MORTH Clause 404.3.1. Shall apply.

B1303.3.2 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 407.4.1.

B1303.3.3 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 pug mill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Employer may permit the mixing to be done in concrete mixers.

B1303.3.4 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 4.75 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.

B1303.3.5 Spreading of Mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base in required 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.

B1303.3.6 The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Employer 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 rotting 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 surface blemishes.

- B1303.3.7 The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied 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.
- B1303.4 **Compaction:**
- B1303.4.1 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 100 mm, a smooth wheel roller of 80 to 100 KN weight may be used. For a compacted single layer up to 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/h.
- B1303.4.2 In portions having unidirectional cross fall/super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the center 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.
- B1303.4.3 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 center parallel to the Centre line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.
- B1303.4.4 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.
- B1303.4.5 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.
- B1303.4.6 Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. 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.
- B1303.4.7 Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8)

- B1303.4.8 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.
- B1303.4.9 Setting and drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.
- B1303.4.10 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.

B1304 BITUMINOUS MATERIAL

B1304.1 Material

B1304.1.1 Materials shall meet the requirements of the relevant IS Codes. These shall be of the following types.

I. Cut back Bitumen

Cut back bitumen shall be Rapid Curing (RC), Medium Curing (MC) or Slow Curing (SC) conforming to IS: 217

II. Cationic Emulsion

Bitumen emulsions of the cationic type for roads shall conform to IS: 8887 Emulsified bitumen shall be Rapid Setting (RS), Medium Setting (MS), or Slow Setting (SS). The physical and chemical requirements of the three types emulsions shall comply with the requirements specified in Table 1 of IS: 8887

III. Paving Bitumen

Paving bitumen shall be conforming to IS:73 and of the following two types:

- (a) Type 1 Paving bitumen from non-waxy crude shall satisfy the requirements given in Table 1 of IS: 73.
- (b) Type 2 Paving bitumen from waxy crude shall satisfy the requirements given in Table 2 of IS:73

The temperature at application of bituminous materials shall be maintained as per manufacturer's instructions and/or as directed by the Employer's Representative.

B1304.2 Methods of Storage and Handling

- (a) Asphaltic material shall be handled and stored with due regard for safety and in such a way that at the time of use in the work the material conforms to the Specifications. Following precautions shall be taken while using these materials:
- (b) Work with these materials shall be carried out in good weather conditions and it shall be carried out in warm and dry weather, and not in wet or extremely cold weather.

- (c) Emulsified asphalt shall be handled with care and not subjected to mechanical shocks or extremes of temperature likely to cause separation of the asphalt. Emulsified asphalt showing sign of separation shall not be used.
- (d) During heating, no water or moisture shall be allowed to enter the boiler.
- (e) Heating of bitumen shall be done to the correct temperature range, as prescribed by the manufacturer for the grade used. The temperature shall be controlled with the use of a suitable thermometer, and the material shall be drawn and used while still at such temperature as is prescribed by manufacturer or in accordance with MORTH/IRC specifications.
- (f) It shall be ensured that mixing of ingredients is thorough and all particles of aggregates are coated uniformly and fully.

B1305 PRIME COAT

B1305.1 Description

B1305.1.1 This work shall consist of the cleaning and preparing of the surface to be primed to specified lines, grade, and cross-section, booming and clearing thoroughly and applying bituminous material in accordance with these Specifications.

B1305.2 Materials

B1305.2.1 The choice of the primer shall depend upon the porosity characteristics of the surface to be primed. The primer shall be Medium Curing Cutback (MC) and the particular grade to be used for the work shall have the consent of the Employer. Slow setting Cationic emulsion conforming to IS:8887 may also be used. Sampling and testing of bituminous primer shall be as per IS:217, IS:454 and IS:8887.

B1305.3 Construction Methods

I. Weather Limitations

Prime coat shall not be applied at a time when the surface is wet or when the weather is foggy, rainy or windy.

II. Equipment

The equipment used for the work shall include a power broom and primer material distributor spraying it uniformly at specified rates and temperatures. It shall be equipped with self-heating arrangement, suitable pump, adequate capacity compressor and spraying bar with nozzles having constant volume or pressure system.

Spraying by manual methods may be allowed for inaccessible or small areas with the consent of the Employer.

III. Cleaning Surface

Immediately prior to applying the prime coat the surface to be primed shall be swept clean from all loose dirt and other objectionable material and shall be shaped to the required lines, grades, cross section.

IV. Application of bituminous primer

B1305.3.1 The primer material shall be applied by means of a distributor at rates usually from 0.8 to 1.4 liters per square meter and at a temperature within the allowable range corresponding to the material used and porosity condition of surface over which it is laid. The temperature of primer at time of application may vary from 40^o C to 60^oC for cutback bitumen and 40^oC to 60^oC for bitumen emulsion. Prime coat shall be allowed to penetrate for at least 48 hours to allow penetration into the base course and aeration of volatile from the primer material, then covered with clean dry sand or stone screening.

B1306 TACK COAT

B1306.1 Description

B1306.1.1 This work shall consist of furnishing and applying bituminous material to an existing road surface or to an existing bituminous prime coat surface which has dried out or preparatory to laying another bituminous layer over it.

B1306.2 Materials

The material for tack coat shall be a bituminous or cut back emulsion of suitable type and grade.

B1306.3 Construction Methods

I. Cleaning Surface

The whole surface on which the tack coat is to be applied shall be cleaned of dust and any extraneous material before the start of application of tack coat by using a power broom or any other equipment/ method.

II. Application of tack coat material

The tack coat material shall be applied uniformly by means of a distributor at controlled rates as per MORTH specifications and at the temperature within the allowable range corresponding to the material used. It shall be done with self-propelled or towed bitumen.

Surfaces of structures and trees adjacent to the areas being treated shall be protected in such a way as to prevent their being spattered or marred.

B1307 DENSE GRADED BITUMINOUS MACADAM

B1307.1 Scope

B1307.1.1 This clause specifies the construction of Dense Graded Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. DBM is also intended for use as road base material. This work shall consist of construction in a single or multiple layer of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50mm to 100mm.

B1307.2 Materials

- B1307.2.1** Bitumen: The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for “Paving Bitumen” IS: 73, and of the penetration indicated for dense bitumen macadam, or this bitumen as modified by one of the methods specified in Clause 521 of MoRTH, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.
- B1307.2.2** Coarse aggregates: The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. Where the Contractor’s selected source of aggregates have poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer’s recommendations, without additional payment. Before approval of the source, the aggregates shall be tested for stripping. The aggregates shall satisfy the physical requirements specified in Table 16.7.1, for dense bituminous macadam.
- B1307.2.3** Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.
- B1307.2.4** Fine aggregates: Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36mm sieve and retained on the 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter.
- B1307.2.5** The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part 37).
- B1307.2.6** The plasticity index of the fraction passing the 0.425 nun sieve shall not exceed 4. When tested in accordance with IS: 2720 (Part 5)
- B1307.2.7** Physical requirements for coarse aggregate for dense graded bituminous macadam Table 16.7.1

Property	Test	Specification	References
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075mm sieve	I.S 2386 Part 1
Particle shape	Flakiness and Elongation Index (Combined)	Max 30%	I.S 2386 Part 1
Strength	Los Angeles Abrasion Value	Max 35% Max 27%	I.S 2386 Part 4

Property	Test	Specification	References
	Aggregate Impact Value		
Durability	Soundness: Sodium Sulphate Magnesium Sulphate	Max 12% Max 18%	I.S 2386 Part 5
Water Absorption	Water absorption	Max 2%	I.S 2386 Part 3
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures ⁷	Minimum retained coating 95%	I.S 6241
Water Sensitivity	Retained Tensile Strength ⁸	Min 80%	AASHTO T283

Notes: -

Aggregate may satisfy requirements of either of Los Angeles Abrasion Value or Aggregate Impact Value

The water sensitivity test is only required if the minimum retained coating in the tripping test is less than 95%.

Filler: Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Employer.

The filler shall be graded within the limits indicated in Table 16.7.2

Table 16.7.2 Grading requirements for mineral filler

IS Sieve (mm)	Cumulative percent passing by weight of total aggregate
0.6	100
0.3	95-100
0.075	85 - 100

B1307.2.8 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 percent by weight of total aggregate, shall be Portland cement or hydrated lime and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 16.7.1, then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.

B1307.2.9 Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in Table 16.7.3, for dense bituminous macadam grading 1 or 2 as specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

Table 16.7.3 Composition of dense graded bituminous macadam pavement layers

Grading	1	2
Nominal aggregate size	40mm	25 mm
Layer Thickness	80-100 mm	50-75 mm
IS Sieve1 (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	95 - 100	100
26.5	63 - 93	90 - 100
19	-	71 - 95
13.2	55 - 75	56 - 80
9.5	-	-
4.75	38 - 54	38 - 54
2.36	28 - 42	28 - 42
1.18	-	-
0.6	-	-
0.3	7 - 21	7 - 21
0.15	-	-
0.075	2 - 8	2 - 8

Grading	1	2
Bitumen content % by mass of total mix ²	Min 4.0	Min 4.5
Bitumen grade (pen)	65 or 90	65 or 90

Notes: -

1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.
2. Determined by the Marshall method.

B1307.3 Mixture design

B1307.3.1 Requirement for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 16.7.4

Table 16.7.4 Requirements for dense graded bituminous macadam

Minimum stability (KN at 60°C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Percent air voids	3-6
Percent voids in mineral aggregate (VMA)	See Table 23.5 below
Percent voids filled with bitumen	65-75

The requirements for minimum percent voids in mineral aggregate (VMA) are set out in Table 16.7.5

Table 16.7.5 minimum percent voids in mineral aggregate (VMA)

Nominal Maximum Particle Size ¹ (mm)	Minimum VMA, Percent Related to Design Air Voids, Percent ²		
	3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0
19.0	12.0	13.0	14.0
25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Notes: -

1. The nominal maximum particle size is one size larger than the first sieve to retain more than 10 percent.
 2. Interpolate minimum voids in the mineral aggregate (VMA) for design. air voids values between those listed.
- B1307.3.2 Binder content: The binder content shall be optimized to achieve the requirements of the mixture set out in Table 16.7.3 and the traffic volume specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in The Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve by the aggregates passing the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Employer.
- B1307.3.3 Where 40 mm dense bituminous macadam mixture is specified, the modified Marshall method described in MS-2 shall be used. This method requires modified equipment and procedures; particularly the minimum stability values in Table 16.7.4 be multiplied by 2.25, and the minimum flow shall be 3 mm.
- B1307.3.4 Job mix formula: The Contractor shall inform the Employer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the following details:
- Source and location of all materials.
- (a) Proportions of all materials expressed as follows where each is applicable.
 - (b) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler.
 - (c) A single definite percentage passing each sieve for the mixed aggregate.
 - (d) The individual grading of the individual aggregate fractions, and the proportion of each in the combined grading.
 - (e) The results of tests enumerated in Table 23.1; 23.2; 23.3 as obtained by the Contractor.
 - (f) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch.
 - (g) Test results of physical characteristics of aggregates to be used.
 - (h) Mixing temperature and compacting temperature.
- B1307.3.5 While establishing 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 mixture and its different ingredients satisfy the physical and strength requirements of these Specifications.
- B1307.3.6 Approval of the job mix formula shall be based on independent testing by the Employer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Employer.

B1307.3.7 The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the Employer for approval before the placing of the material.

B1307.3.8 Plant trials - permissible variation in job mix formula: Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 16.7.6 these variations are intended to apply to individual specimens taken for quality control tests in accordance with Section 900 of MoRTH

Table: 16.7.6 permissible variations from the job mix formula

Description	Permissible Variations Base/binder course/Wearing course	
	Base/binder course	Wearing course
Aggregate passing 19mm sieve or larger	± 8%	± 7%
Aggregate passing 13.2mm, 9.5mm	± 7%	± 6%
Aggregate passing 4.75mm	± 6%	± 5%
Aggregate passing 2.36mm, 1.18mm, 0.6mm	± 5%	± 4%
Aggregate passing 0.3mm, 0.15mm	± 4%	± 3%
Aggregate passing 0.075mm	± 2%	± 1.5%
Binder content	± 0.3%	± 0.3%
Mixing temperature	± 10°C	± 10°C

B1307.3.9 Once the plant trials have demonstrated the capability of the plant, and the trials are approved, the laying operation may commence. Over the period of the first month of production for laying on the works, the Employer shall require additional testing of the product to establish the reliability and consistency of the plant.

- B1307.3.10 Laying Trials: Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid and compacted all in accordance with Clause 501 of MoRTH. The laying trial shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing, by the Employer. The area of the laying trials shall be a minimum of 100 Sq.m of construction similar to that of the project road, and it shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.
- B1307.3.11 The Contractor shall previously inform the Employer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method.
- B1307.3.12 Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Employer, who may at his discretion require further laying trials.
- B1307.4 **Construction Operations**
- B1307.4.1 Weather and seasonal limitations: The provisions of Clause 501.5.1 of MoRTH shall apply.
- B1307.4.2 Preparation of base: The base on which Dense Graded Bituminous Material is to be laid shall be prepared in accordance with Clauses 501 and 902 of MoRTH as appropriate, or as directed by the Employer. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air. In locations where-mechanical broom cannot access, other approved methods shall be used as directed by the Employer.
- B1307.4.3 Stress absorbing layer: Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 522 of MoRTH.
- B1307.4.4 Prime coat: Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of Clause 502 of MoRTH, or as directed by the Employer.
- B1307.4.5 Tack coat: Where the material on which the dense bituminous macadam is to be placed is a bitumen bound surface, a tack coat shall be applied as specified, in accordance with the provisions of Clause 503 of MoRTH, or as directed by the Employer.
- B1307.4.6 Mixing and transportation of the mixture: The provisions as specified in Clauses 501.3 and 501.4 of MoRTH shall apply.

B1307.5 Opening to Traffic

B1307.5.1 The newly laid surface shall not be open to traffic for at least 24 hrs after laying and completion of compaction, without the express approval of the Employer in writing.

B1308 BITUMINOUS CONCRETE

B1308.1 Description

B1308.1.1 This work shall consist of a surfacing of single-layer bituminous concrete of specified thickness on previously prepared bituminous surface to the lines, grades, dimensions and cross section as shown on Drawings. It shall be 25mm/40mm thick as required by Employer.

B1308.2 Materials

I. Bitumen

The bitumen shall be paving bitumen of suitable penetration grade within the range S 35 to S 90 or A 90 to IS:73. The actual grade of bitumen to be used shall be appropriate to the requirements of the work and environmental conditions.

II. Coarse aggregates

The aggregates shall satisfy the physical requirements given in Table 16.7.1 Flakiness index shall not exceed 30% and water absorbed not more than 1%.

III. Fine aggregates

Fine aggregates shall be the fraction passing 2.36 mm sieve and retained on 75 microns sieve, consisting of crushed run screenings, natural 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.

IV. Filler

Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement. The filter shall be graded within following limits specified in Table 16.8.1

TABLE 16.8.1

IS Sieve	Percent passing by weight
600 microns	100
300 microns	95 – 100
75 microns	85 – 100

- V. The filter 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 coarse aggregate is gravel, 2 percent of mass of total aggregate of Portland cement or hydrated lime shall be added and percentage of fine aggregate reduced accordingly. Cement or lime is not required when the gravel is lime stone.
- VI. Aggregate gradation
Mineral aggregates, including filler shall be so graded or combined as to conform to grading set-forth in in Table 16.8.2 below.

Table 16.8.2

Sieve Designation	Percent by weight passing through sieve for		
	25 mm thick Grade 1	25-40 mm thick Grade 2	>40 mm thick Grade 1
26.5 mm	--	--	100
22.4 mm	--	100	75-100
13.2 mm	100	80-100	--
11.2 mm	90-100	75-95	50-85
5.6 mm	60-80	55-75	20-40
2.8 mm	40-55	40-55	5-20
710 microns	20-30	20-30	--
300 microns	15-25	15-25	--
180 microns	10-20	10-20	--
90 microns	5-11	5-11	0-5

B1308.3 Mix Design

I. Requirement of Mix

Apart from conformity with grading and quality requirements of individual ingredients the mix shall also meet the requirements set forth in Table 16.8.3

Table 16.8.3- Requirements of bituminous concrete

S. No.	Description	Requirements
1.	Marshall stability (ASTM Designation: D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 Kg (1800 pounds)

S. No.	Description	Requirements
2.	Marshall flow (mm)	Minimum 2-4
3.	Percent air voids in mix	3-5
4.	Percent voids in mineral aggregate (VMA)	Minimum 11-13
5.	Percent voids in mineral aggregates filled by bitumen (VFB)	65-75
6.	Binder content, percent by weight of mix	Minimum 4.5
7.	Water sensitivity (ASTM: D-1075) loss of Stability on immersion in water at 60 deg. C	Minimum 75% Retained strength
8.	Swell Test (Asphalt Instt. MS-2, No. 2)	Maximum 1.5%

II. Binder content

Binder content shall be so determined as to achieve the requirements of the mix set forth in Table 16.8.3. Marshall method for arriving at binder content shall be adopted.

III. Job Mix Formula

Before starting work the Contractor shall submit to the Employer for his consent. The job mix formula for the mixture shall fix a single percentage of aggregate passing each required sieve size, a single percentage of asphalt to be added to the aggregate, and a single temperature at which the mixture is to be delivered on the road, all of which shall fall within the ranges of the composition and the temperature limits. The formula shall give the following details.

1. Source and location of all materials
2. Proportions of all materials as described under :
 - Binder as percentage by weight of total mix
 - Coarse aggregate as percentage by weight of total.
 - Fine aggregate including mineral filler.
 - Mineral Filler
3. A single definite percentage passing each sieve for the mixed aggregate.
4. The results of test as obtained by the Contractor.
5. Test results of physical characteristics of aggregates to be used.
6. Mixing temperature and compacting temperature.

- IV. Application of job-mix formula and Allowable Tolerances
The approved job mix formula shall remain effective unless and until modified. Each day as many samples of the materials and mixtures shall be taken and tested considers necessary for checking the required uniformity of the mixture.
All mixture furnished shall conform to the job-mix formula within the range of tolerances set in forth in Table 16.8.4.
When unsatisfactory results or changed conditions make it necessary, a new job mix shall be submitted to the Employer.
Should a change in a material be encountered or should a change in a source of material be made, a new job mix formula shall be submitted before the mixture containing the new material is delivered.

Table 16.8.4- Permissible variation from the job-mix formula

S. No.	Description of Ingredients	Permissible Variation by Weight of Total mix in Percentage
1.	Aggregate passing 13.2mm sieve and larger	+ 8
2.	Aggregate passing 9.5mm sieve and 4.75mm sieve	+ 7
3.	Aggregate passing 2.36mm sieve & 1.18mm sieve	+ 6
4.	Aggregate passing 600 μ sieve & 300 μ sieve	+ 5
5.	Aggregate passing 150 microns sieve	+ 4
6.	Aggregate passing 75 microns sieve	+ 3
7.	Binder	+ 0.3
8.	Mixing Temperature (Centigrade)	+ 10

B1308.4 **Construction Methods**

- I. Weather Limitation
The control over the weather conditions shall be as described as per MORTH Clause 501.5.1 shall apply.

- II. Progress of Work
No work shall be performed when there is insufficient hauling, spreading or finishing equipment, or labour to ensure progress at a rate not less than 75% of the capacity of the mixing plant.
- III. Preparation of Existing Surface
The surface on which the mix is to be laid shall be swept thoroughly and cleaned of all loose dirt and other objectionable material using mechanical broom immediately before start of work, in portions where mechanical means cannot reach.
The surface shall be prepared, shaped and conditioned to specified levels, grade and cross-fall (camber).
- IV. Preparation of Mix
A Hot-mix plant of adequate capacity and capable of producing a proper and uniform quality mix shall be used for preparing the mix. The plant may be either a weigh batch type or volumetric proportioning continuous or drum mix type. The plant shall have co-ordinated set of essential units capable of producing uniform mix as per the job-mix formula.
The temperature of the binder at the time of mixing shall be in the range of 150 to 163 degree C and of aggregates in the range of 155 to 163°C. Provided also that at no time shall the difference in temperature between the aggregates and binder exceed 14°C. The Contractor shall submit the exact temperatures and total mixing time for the consent of the Employer. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of mineral aggregates are coated uniformly.
- V. Transportation and Delivery of Mix.
The mix shall be transported from the mixing plant to the point of use in suitable tipper vehicles. The vehicles employed for the transport shall be clean and be covered in transit.
- VI. Spreading and Finishing
The mix transported from the hot mix plant to the site and shall be spread by means of a self-propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grade, elevation, and cross-section. However, in restricted locations and narrow widths, available equipment cannot be operated, other suitable means shall be employed subject to the consent of the Employer. The mixture shall be laid upon an approved surface and only when weather conditions are considered suitable. The temperature of the mix, at the time of laying, shall be in the range of 120°C to 160°C.

The prime coat and tack coat to be applied shall be as per Sub-sections 16.5 and 16.6 respectively.

Spreading, finishing and compacting of the mix shall be carried out during daylight hours only, unless satisfactory illumination is provided by the Contractor.

VII. Compaction of Mixture

Immediately after spreading of mix by paver, it shall be thoroughly and uniformly compacted by rolling with a set of self-propelled rollers moving at a speed not more than 5 km per hour, immediately following close to the paver. Generally with each paver, two steel wheeled tandem rollers and one pneumatic tired roller will be required. The initial or breakdown rolling shall be with 8 to 10 ton static weight smooth three wheeled steel roller and finish rolling with 6 to 8 ton tandem roller. The breakdown rolling shall preferably be followed by an intermediate rolling with a smooth wheel pneumatic roller of 10 to 25 ton having a tire pressure of 7kg/sq. cm moving with a speed not more than 7 km per hour and shall be at all times slow enough to avoid displacement of the hot mixture. Means shall be provided for checking and adjusting the tire pressure on the job at all times. All compaction operations, i.e., breakdown rolling can be accomplished by using vibratory roller of 8 to 10 ton static weight. During initial or breakdown rolling and finished rolling, the vibratory shall be switched off. The joints and edges shall be rolled with an 8 to 10 ton three wheeled static roller.

No delays in rolling the paved surface shall be permitted. The breakdown roller must be right up to the paver at all times and the intermediate pneumatic roller right up to the breakdown roller. The compaction of the asphaltic concrete shall be controlled by temperature as follows:

Roller	Temperature
Breakdown	120°C - 135°C
Pneumatic	95°C - 115°C
Finishing	< 65°C

Rolling shall be continued till the density achieved is at least 98% of that of laboratory Marshall Specimen. Rolling operations shall be completed in all respects before the temperature of the mix falls below 100°C.

VIII. Joints

Both longitudinal and lateral joints in successive courses shall be staggered so as not to be one above the other. Longitudinal joints and edges shall be constructed true to delineating lines parallel to the centre line of the road. Longitudinal joints shall be offset by at least 150mm from those in the lower course.

Longitudinal and transverse joints shall be made in a careful manner so that well bonded and sealed joints are provided for the full depth of the course.

IX. Surface regularity

Surface shall be tested for undulations in longitudinal and cross profiles with 3 m straight edge and crown template respectively. Crown template shall conform to the typical cross section.

Maximum permissible undulation in longitudinal profile with 3m straight edge shall be as 8mm.

Maximum permissible variation from specified cross profile under camber template shall be as 4mm.

Surface evenness requirements in respect of both longitudinal and cross profiles should be simultaneously satisfied.

X. Protection of the pavement from traffic

Subsection 16.1 shall apply except as stated below.

Section of the newly finished works shall be protected from traffic of any kind until the mixture has cooled to approximately ambient air temperature and well set.

B1309 SEAL COAT

B1309.1 Description

B1309.1.1 This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade, and cross fall. Seal coat used shall be of premix type unless otherwise approved by the Employer.

I. Binder

The binder shall be bitumen of a suitable grade appropriate to the requirements of the work and other environmental conditions as directed by the Employer and satisfying the requirements of IS:73, 217, 454 or other cut back as applicable.

II. Aggregates

The aggregates shall be sand or grit and shall consist of clean, hard, durable, dry particles and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregates shall pass 2.36mm sieve and be retained on 180 microns sieve. The quantity used for premixing shall be 0.06 cum per 10 Sqm area.

B1309.2 Construction Method

I. Preparation of base

The seal coat shall be applied immediately after laying of bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other objectionable matter.

II. Preparation and Application of Mix

Mixtures of approved type shall be employed for mixing aggregates with suitable bituminous binder. The binder shall be heated in boilers of suitable design, to a temperature appropriate to the grade of bitumen. The aggregates shall be clean, dry and suitably heated to a temperature before the same are placed in the mixture. Mixing of binder with aggregates to specified proportions shall be continued till the latter are thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

III. Rolling

As soon as sufficient length has been covered with pre-mixed material, the surface shall be rolled with 8- 10 ton smooth wheeled steel, suitable vibratory, or other equipment.

IV. Control of Traffic

Subsection 16.1 shall apply.

B1310 TRAFFIC SIGNS, MARKINGS ON JETTY AND OTHER ROAD APPURTENANCES

B1310.1 General

B1310.1.1 The colour, width and layout of road marking shall be in accordance with the Code of Practice for Road Markings with paints, IRC: 35/MORTH, and as specified in the drawings or as directed by the Employer.

B1310.2 Materials

B1310.2.1 Road markings shall be of ordinary road marking paint, hot applied thermoplastic compound, or reflectorized paint as specified in the item and the material shall meet the requirements as specified below.

B1310.3 Ordinary Road Marking Paint

B1310.3.1 Ordinary paint used for road marking shall conform to Grade I as per IS: 164. The road marking shall preferably be laid with appropriate road marking machinery. Laying thickness of road marking paint shall be as specified by the Employer. Hot Applied Thermoplastic Road Marking

B1310.4 General

- (a) The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.
- (b) The thermoplastic compound shall be screeded/extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- (c) The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Employer.
- (d) Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

B1310.5 Thermoplastic Material

B1310.6 General

B1310.6.1 The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Employer.

B1310.7 Requirements

- (a) **Composition:** The pigment, beads, and aggregates shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in table 16.10.1

Table: 16.10.1

Portions of constituents of marking material (percentage by weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-40	30-40
Titanium Dioxide	10.0 min.	-

Component	White	Yellow
Calcium Carbonate and Inert Fillers	42.0 max.	See Note below
Yellow Pigments	-	See Note below

Note: Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met.

- (b) **Properties: The properties** of thermoplastic material, when tested in accordance with ASTM D36/BS-3262- (Part I), shall be as below:
- (i) **Luminance:**
 - White: Daylight luminance at 45 degrees – 65 percent min. as per AASHTOM 249
 - Yellow: Daylight luminance at 45 degrees - 45 percent min. as per AASHTOM 249
 - (ii) **Drying time:** When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.
 - (iii) **Skid resistance:** not less than 45 as per BS 6044.
 - (iv) **Cracking resistance at low temperature:** The material shall show no cracks on application to concrete blocks.
 - (v) **Softening point:** 102.5 ± 9.5o C as per ASTM D 36.
 - (vi) **Yellowness index (for white thermoplastic paint):** not more than 0.12 as per AASHTO M 249
- (c) **Storage life:** The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or un-melted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.
- (d) **Reflectorisation:** Shall be achieved by incorporation of beads, the **grading** and other properties of the beads shall be as specified in Clause 1803.1
- (e) **Marking:** Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:
- (i) The name, trade mark or other means of identification of manufacturer
 - (ii) Batch number
 - (iii) Date of manufacture
 - (iv) Colour (white or yellow)
 - (v) Maximum application temperature and maximum safe heating temperature.

- (f) **Sampling and testing:** The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM /BS method. The **Contractor** shall furnish to the Employer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

Reflectorizing glass beads

General: This Specification covers two types of glass beads to be used for the production of reflectorized pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table below and Type 2 beads are those which are to be sprayed on the surface.

The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions.

B1310.8 Specific Requirements

- (a) **Gradation:** The glass beads shall meet the gradation requirements for the two types as given in Table 16.10.2 below.

Table 16.10.2
Gradation requirements for glass beads

Sieve Size	Percent retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 microns	5 to 20	0 to 5
600 –do-	-	5 to 20
425 –do-	65 to 95	-
300 –do-	-	30 to 75
180 –do-	0 to 10	10 to 30
Below 180 microns	-	0 to 15

- (b) **Roundness:** The glass beads shall have a minimum of 70 percent true spheres.
- (c) **Refractive index:** The glass beads shall have a minimum refractive index of 1.50.
- (d) **Free flowing properties:** The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.

Test methods: The specific requirements shall be tested with the following methods:

- (a) Free-flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter desiccator which is filled within 25 mm of the top of a desiccator plate with sulphuric acid water solution (specific gravity 1.10). Cover the desiccator and let it stand for 4 hours at 20 to 29 degree C. Remove sample from desiccator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be essentially free of lumps and clusters and shall flow freely through the funnel.
- (b) The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS:6088 and BS:3262 (Part I).
- (c) The Contractor shall furnish to the Employer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all specified herein and shall certify that the material meets all requirements of this Specifications. However, if so required, these tests may be carried out as directed by the Employer.

B1310.9 Application properties of thermoplastic material

B1310.9.1 The thermoplastic material shall readily get screeded/extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

B1310.9.2 The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

B1310.10 Preparation

- (a) The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- (b) After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

B1310.11 Reflectorized Paint

B1310.11.1 Reflectorized paint, if used, shall conform to the Specification by the manufacturers and approved by the Employer. Reflectorizing glass beads for reflectorizing paints where used shall conform to the requirement of Clause 1603.4.3.

B1310.12 Application

B1310.12.1 Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Employer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

B1310.12.2 Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and /or curing compound shall be removed before the markings are applied.

B1310.12.3 The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

B1310.12.4 The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

B1310.12.5 The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes place.

B1310.12.6 Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square meter area.

B1310.12.7 The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS-3262 (Part 3).

B1310.12.8 The markings shall be done to accuracy within the tolerances given below:

- (a) Width of lines and other markings shall not deviate from the specified width by more than 5 percent
- (b) The position of lines, letters, figures, arrows and other markings shall not deviate from the position specified by than 20mm.

- (c) The alignment of any edge of a longitudinal line shall not deviate from the specified alignment by more than 10mm in 15m.
- (d) The length of segment of broken longitudinal lines shall not deviate from the specified length by more than 150mm.

In broken lines, the length of segment and the gap between segments shall be as indicated on the drawings; if these lengths are altered by the Employer, the ratio of the lengths of the painted sections shall remain the same.

B1310.13 Properties of Finished Road Marking

B1310.13.1 The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level uniform and free from streaks.

- (a) The stripe shall not be slippery when wet.
- (b) The marking shall not lift from the pavement in freezing weather.
- (c) After application and proper drying, the stripe shall show no appreciable deformation or discolouration under traffic and under road temperatures up to 60°C.
- (d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.
- (e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- (f) The colour of yellow marking shall conform to IS Colour No. 356 as given in IS: 164.

B1311 EARTH WORK

B1311.1 Soil

B1311.1.1 This shall comprise topsoil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yield to the ordinary application of pick, spade and/or shovel, rake or other ordinary digging equipment. Removal of gravel or any other modular material having dimension in any one direction not exceeding 75 mm shall be deemed to be covered under this category.

B1311.2 Stripping and storing top soil:

B1311.2.1 When so directed by the Employer, the topsoil existing over the sites of excavation shall be stripped to specified depths constituting Horizon "A" and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, medians and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots, with approval of the Employer.

B1311.3 Excavation

- B1311.3.1 All excavations shall be carried out in conformity with the directions laid here in under and in a manner approved by the Employer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilized as decided upon beforehand.
- B1311.3.2 While planning or executing excavations, the Contractor shall take all-adequate precautions against soil erosion, water pollution etc. and take appropriate drainage measures to keep the site free of water.
- B1311.3.3 The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Employer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/ width excavated beyond the specified levels/dimensions on the drawings shall be made good at the cost of the Contractor with suitable material of characteristics similar to that removed and compacted to the requirements.
- B1311.3.4 All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes, these shall be excavated to approved depth on instructions of the Employer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.
- B1311.3.5 After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place. If trees were removed, new trees shall be planted, as directed by the Employer. The cost of planting new trees shall be deemed to be incidental to the work.
- B1311.3.6 Methods, tools and equipment: Only such methods, tools and equipment as approved by the Employer shall be adopted/used in the work. If so desired by the Employer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

B1311.4 Slides:

B1311.4.1 If slips, slides, over-breaks or subsidence occur in cuttings during the process of construction, they shall be removed at the cost of the Contractor as ordered by the Employer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction. The classification of the debris material from the slips, slides etc. shall conform to its condition at the time of removal and payment made accordingly regardless of its condition earlier.

B1311.5 Dewatering:

B1311.5.1 If water is met with in the excavations due to springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Employer. Care shall be taken to discharge the drained water into suitable outlets as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage. Dewatering will not be paid extra. It will be included in the respective earth work/RCC items.

B1311.5.2 Disposal of excavated materials: All the excavated materials shall be the property of the Employer. The material obtained from the excavation of roadway, shoulders, verges, drains, cross-drainage works etc., shall be used for filling up of (i) roadway embankment, (ii) the existing pits in the right-of-way and (iii) for landscaping of the road as directed by the Employer, including levelling and spreading with all lifts and lead upto 5000 m and no extra payment shall be made for the same.

B1311.6 Backfilling:

B1311.6.1 Backfilling of masonry/concrete/hume pipe drain excavation shall be done with approved material after concrete/masonry/hume pipe is fully set and carried out in such a way as not to cause undue thrust on any part of the structure and/or not to cause differential settlement. All space between the drain walls and the side of the excavation shall be refilled to the original surface making due allowance for settlement, in layers generally not exceeding 150 mm compacted thickness to the required density, using suitable compaction equipment such as mechanical tamper, rammer or plate compactor as directed by the Employer.

- B1311.6.2 The Contractor shall undertake all reasonable precautions for the protection and preservation of any or all existing roadside trees, drains, sewers or other sub-surface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which, in the opinion of the Employer, shall be continued in use without any change. Safety measures taken by the Contractor in this respect shall be got approved from the Employer. However, if any of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition at his expense. If the Contractor fails to do so, within the required time as directed by the Employer or if, in the opinion of the Employer, the actions initiated by the Contractor to replace/restore the damaged objects are not satisfactory, the Employer shall arrange the replacement/ restoration directly through any other agency at the risk and cost of the Contractor after issuing a prior notice to the effect.
- B1311.7 Preparation of Cut Formation**
- B1311.7.1 Where the material in the subgrade (that is within 500 mm from the lowest level of the pavement) has a density less than specified the same shall be removed to a depth of 500 mm and compacted in layers in accordance with the requirements of subgrade.
- B1311.7.2 Any unsuitable material encountered in the subgrade level shall be removed as directed by the Employer and replaced with suitable material compacted in accordance with the specifications of subgrade.
- B1311.7.3 In rocky formations, the surface irregularities shall be corrected and the levels brought up to the specified elevation with granular base material as directed by the Employer, laid and compacted in accordance with the respective Specifications for these materials. The unsuitable material shall be disposed of in accordance with the specifications. After satisfying the density requirements, the cut formation shall be prepared to receive the subbase/base course in accordance with the specifications to receive the sub-base/base course.
- B1311.8 Excavation for structures:**
- B1311.8.1 Excavation for structures shall consist of the removal of material for the construction of foundations for buildings and other similar works, in accordance with the requirements of these Specifications and the lines and dimensions shown on the drawings or as indicated by the Employer. The work shall include construction of the necessary cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining and pumping; the removal of all grubs and other deleterious matter and obstructions, necessary for placing the foundations; trimming bottoms of excavations; backfilling and clearing up the site and the disposal of all surplus material.

B1311.9 Embankment construction including subgrade

B1311.9.1 These Specifications shall apply to the construction of embankments including subgrades, earthen shoulders and miscellaneous backfills with approved material obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Employer.

B1311.10 Materials and General Requirements

B1311.11 Physical requirements:

B1311.11.1 The materials used in embankments, subgrades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the Employer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ subgrade.

The following types of material shall be considered unsuitable for embankment:

- (a) Materials from swamps, marshes and bogs;
- (b) Peat, log, stump and perishable material; any soil that classifies as OL, O1, OH or Pt in accordance with IS: 1498;
- (c) Materials susceptible to spontaneous combustion;
- (d) Materials in a frozen condition;
- (e) Clay having liquid limit exceeding 50 and plasticity index exceeding 25; and
- (f) Materials with salt resulting in leaching in the embankment.

B1311.11.2 Expansive clay exhibiting marked swell and shrinkage properties ("free swelling index" exceeding 50 percent when tested as per IS: 2720 - Part 40) shall not be used as a fill material. Where expansive clay with acceptable "free swelling index" value is used as a fill material, subgrade and top 500 mm portion of the embankment just below subgrade shall be non-expansive in nature.

B1311.11.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO₃) per liter when tested in accordance with BS: 1377 Test 10 but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works.

B1311.11.4 Materials with a total sulphate content (expressed as SO₃) exceeding 0.5 percent by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited within 500 mm, or other distances described in the Contract, of metallic items forming part of the Permanent Works.

B1311.11.5 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in the subgrade. However, the Employer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle, size shall not be more than two-thirds of the compacted layer thickness.

B1311.11.6 Ordinarily, only the materials satisfying the density requirements given in Table below shall be employed for the construction of the embankment and the subgrade.

B1311.12 Density Requirements of Embankment and Subgrade Materials

S. No.	Type of Work	Maximum laboratory dry unit weight when tested as per IS: 2720 (Part 8)
1	Embankments up to 3 meters	Not less than 15.2 kN/cu.m. height, not subjected to extensive flooding.
2	Embankments exceeding 3 meters height or embankments of any height subject to long periods of inundation	Not less than 16.0 kN/cu. m.
3	Subgrade and earthen shoulders/verges/backfill	Not less than 17.5 kN/cu. m.

The design four as soaked CBR for the material to be used in subgrade is 10.

B1311.13 General requirements:

B1311.13.1 The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

B1311.13.2 The work shall be so planned and executed that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

B1311.14 Borrow materials

- B1311.14.1** Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Employer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer, arrangement for locating the source of supply of material for embankment and subgrade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor. Borrow pits along the road shall be discouraged. Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.
- B1311.14.2** No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, and then he shall make good any consequent deficit of material arising there from.
- B1311.14.3** Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Employer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.
- B1311.14.4** The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or siting of temporary buildings or structures.
- B1311.14.5** The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Employer. It shall be ensured that the subgrade material when compacted to the density requirements as in Table 300-2 of MoRTH shall yield the design CBR value of the subgrade.

Type of work/material	Relative compaction as percentage of max. laboratory dry density as per IS: 2720 (Part 8)
1. Subgrade and earthen shoulders	Not less than 97
2. Embankment	Not less than 95

- B1311.14.6** The Contractor shall at least 7 working days before commencement of compaction submit the following to the Employer for approval:
- The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

- A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.
- Once the above information has been approved by the Employer, it shall form the basis for compaction.

B1312 BITUMINOUS MACADAM

B1312.1 This work shall consist of laying and compacting clean, crushed, graded aggregate mixed with bitumen, to a dense mass on a prepared base or existing pavement as the case may be in accordance with the requirements of these Specifications or as per IRC & MORTH standards. 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 Employer.

B1312.2 Bitumen:

B1312.2.1 The bitumen shall be paving bitumen of suitable penetration grade VG-30 (60/70 Grade) as per IS: 73.

B1312.3 Aggregate:

B1312.3.1 The aggregates shall consist of Stone aggregate. They shall be clean, strong, durable, of fairly cubical shape and free from disintegrated pieces, organic or other deleterious matter and adherent coating. If crushed shingle/gravel is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall preferably be hydrophobic and of low porosity. The minimum retained coating shall be 95%. If hydrophilic aggregates are to be used, the bitumen shall preferably be treated with anti-stripping agents of approved quality in suitable dose.

B1312.4 Physical requirements of aggregates for bituminous macadam

S.No	Test	Test Method	Requirement
1.	Los Angeles Abrasion Value*	IS: 2386 (Part-4)	40 percent Maximum
2.	Aggregate Impact Value *	IS: 2386 (Part-4)	30 percent Maximum
3.	Flakiness and Elongation Indices (Total) **	IS: 2386 (Part-1)	35 percent Maximum
4.	Coating and Stripping of Bitumen Aggregate Mixtures	IS 6241	Minimum retained coating 95 percent
5.	Soundness (i) Loss with Sodium Sulphate 5 cycles (ii) Loss with Magnesium Sulphate 5 cycles	IS: 2386 (Part-5)	12 percent Maximum 18 percent Maximum

S.No	Test	Test Method	Requirement
6.	Water absorption	IS: 2386 (Part-3)	2.0 percent Maximum
7.	Retained tensile strength	AASHTO 283	Min-80 percent

B1312.5 Proportioning of materials:

B1312.5.1 The bitumen content BM shall be 3.4 percent by weight of the total mix except when otherwise directed by the Employer.

B1312.6 Aggregate grading for bituminous macadam

B1312.6.1 As per MoRTH

B1312.7 Job mix formula:

B1312.7.1 The Contractor shall inform the Employer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the following details:

- (i) Source and location of all materials;
- (ii) Proportions of all materials expressed as follows where each is applicable:
- (iii) Binder type, and percentage by weight of total mixture;
- (iv) A single definite percentage passing each sieve for the mixed aggregate;
- (v) The individual grading of the individual aggregate fractions, and the proportion of each in the combined grading.
- (vi) The results of tests enumerated in Table 500-11MoRTH as obtained by the Contractor;
- (vii) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch,
- (viii) Test results of physical characteristics of aggregates to be used;
- (ix) Mixing temperature and compacting temperature.

B1312.7.2 While establishing 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 mixture and its different ingredients satisfy the physical and strength requirements of these Specifications.

B1312.7.3 Approval of the job mix formula shall be based on independent testing by the Employer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Employer.

B1312.7.4 The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the Employer for approval before the placing of the material.

B1400 LANDSCAPING

B1401 SOIL AND ITS PREPARATION

B1401.1 The soil shall be prepared by mixing it with sand in the specified proportions to improve the quality. Rubble and large particles in the soil shall be removed as directed before backfilling in pits and trenches. The excavated earth if found satisfactory shall be reused for backfilling after mixing with sand and manure. In case the excavated earth is found unsuitable for back filling, good earth (top soil red earth) shall be brought from outside. The cost of sand and red earth if brought from outside shall be measured in stacks and paid separately. Any surplus earth shall be disposed off as directed without any extra cost.

B1402 ORGANIC MANURES FOR THE PREPARATION OF PITS AND TRENCHES

B1402.1 Organic manures to be used for preparation of pits and soil beds shall be dried, well decomposed old cow dung and shall be measured in stacks and paid separately. All other manures which are necessary for the upkeep and proper maintenance of the plants shall be supplied by the contractor free of cost as and when directed by the Employer.

B1403 POTS AND CONTAINERS

B1403.1 Pots and containers for indoor plants shall be of the specified size. They shall be of approved quality and shape. The pots should have proper drainage facilities which is vital to the plant. The pots shall also be provided with two coats of approved paint without any extra cost.

B1403.2 For maintaining plants in the nursery, polythene bags may be used which has holes punched at the bottom for proper drainage. The containers and pots shall be filled with approved medium which shall vary from plant to plant and shall be done as directed by the Employer. Potting shall be done as per standard practices. Repotting if required shall be done by the Contractor at no extra cost during the maintenance period.

B1404 WATERING

B1404.1 It shall be the responsibility of the Contractor to adequately water the plants different times during the day as directed, without any extra cost.

B1405 FERTILIZERS

B1405.1 Application of fertilizers which shall vary according to the plant species shall be done at specified intervals as directed at no extra cost. The Contractor shall make available approved fertilizers well in advance for timely application.

B1406 PESTICIDES, FUNGICIDES, TERMICIDES

B1406.1 It shall be the responsibility of the Contractor to protect the plants from diseases by periodic spraying of selected fungicides and pesticides for which nothing extra shall be paid. Only green and blue colour coded inorganic Fertilizers/pesticides shall be used. Prohibited Fertilizers/Pesticides shall not be used.

B1407 WATERING OF THE PLANTED SPECIES

B1407.1 The Contractor shall visit the site and acquaint himself of the infrastructure available to him for watering the plants. Owner shall permit the contractor to avail the existing facilities such as pipe networks and water sources available in the site for watering the plants. However, pumping of water through this pipe network, cost and maintenance of pumps and motors, maintenance of the pipe lines, valves, power charges and other incidental expenses shall be borne by the Contractor at no extra cost. However, if any of these facilities fail to work or if the water sources go dry it shall be the sole responsibility of the contractor to make alternate arrangements for the conveyance of water from external sources and watering the plants at no extra cost.

B1408 MAINTENANCE CREW

B1408.1 The Contractor shall be responsible for employing specified number of skilled gardeners and supervising staff as directed by the Employer for the proper upkeep of the plants during the period of execution and from the date of taking over of the site. The duty hours of the staff and gardeners shall be specified by the Employer. The supervising staff and the gardeners shall report to the concerned officer deputed by Owner and it shall be the responsibility of the contractor to ensure the presence of the staff in the site during working hours and he shall have to maintain such records on his employees as directed. In case any of his staff proceeds on leave the contractor shall substitute additional personnel to carry out the work.

B1408.2 The contractor shall ensure proper conduct and discipline from his staff. If any of the employees of the Contractor fails to discharge his duties to the best interest of the project, the Employer shall give it in writing to the Contractor to replace that employee and within one week the Contractor shall have to replace him with a suitable person.

B1408.3 The Contractor shall have to bear all expenses of his maintenance crew including salary and all additional benefits such as insurance of the workers, medical aids and/or other benefits and nothing extra shall be admissible due to any reason whatsoever. The contractor shall have to maintain proper attendance records for the compliance of the prevailing labour laws of the state and shall also maintain necessary documents and records to comply with statutory regulations such as ESI, Bonus, Gratuity and/or other Acts prevailing in the State.

B1408.4 The Contractor shall provide necessary transport facilities within the site for transportation of his personnel equipment and tools. The Contractor shall make available necessary tools, garden implements, equipment, transport facilities, in required numbers as directed at no extra cost and safe storage and maintenance of the same shall be his responsibility.

B1408.5 The Contractor shall engage security staff round the clock for the safety of the plants at the nursery and other locations in the site and nothing extra shall be paid for the same.

B1408.6 The contractor shall also bear all incidental expenses for movement of plants/pots within the site, shifting of pots and plants to and from the nursery at regular intervals, repotting of plants if required, changing the media at specified intervals, trimming the plants and/or other works as directed by the Employer for the proper maintenance.

B1409 GENERAL

B1409.1 The various plants shall be delivered at the site as per the prescribed time schedule and shall be maintained at the site before planting. The contractor has to bear all expenses for application of manure, fungicides, insecticides at specified intervals as directed by the Employer for the proper upkeep of the plants, during the maintenance period. Nothing extra shall be paid for such incidental expenses for the healthy maintenance of the plants.

B1409.2 It shall be sole responsibility of the Contractor to maintain all the plants, and other allied items of work executed under this contract in a healthy and sound conditions throughout the period of execution, and the period of maintenance. Should any plant found defective during the maintenance period by the Employer, the Contractor shall replace the same with healthy ones and maintain them for further specified period as directed by the Employer.

B1409.3 In case the Contractor fails to replace the defective plants during the maintenance period a minimum recovery of double the rate of planting charges of that particular plant species shall be effected. The Employer reserves the right to impose additional penalty depending on the growth and category of the defective plant, and this shall be recovered from any amount payable to the Contractor as per the terms of the contract.

B1409.4 The Contractor shall procure at least 10% of the total number of plants in each species (or more if directed by the Employer) at no extra cost and maintain at the site to take care of the mortality of planted species.

B1409.5 The Contractor shall submit a programme chart giving the details of his schedule of procurement of various species and planting them at various locations, the details regarding the number of staff and labourers proposed to be employed by him for this work, etc. to the Employer before the commencement of the work

B1410 SUPPLYING GOOD EARTH

B1410.1 The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.

B1411 SUPPLY AND STACKING OF SLUDGE

B1411.1 It shall be transported to the site in lorries with efficient arrangement to prevent spilling enroute. It shall be stacked at site. Each stack shall not be less than 50 cm height and volume not less than 3 cum.

B1412 SPREADING GOOD EARTH

B1412.1 Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Employer. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

B1413 SPREADING SLUDGE/MANURE

B1413.1 Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Employer. The mixing shall be spread as described and as directed by Employer.

B1413.2 Measurements: The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth and sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

B1414 MIXING OF GOOD EARTH AND SLUDGE/MANURE

B1414.1 The stacked earth shall, before mixing be broken down top particle of sizes not exceeding 6 mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Employer.

B1415 GRASSING WITH SELECT GRASS

B1415.1 The area from where the grass roots are to be obtained shall be specified by the Employer-in Charge at the time of execution of the work and no royalty shall be charged on this account from the contractor. Grass is to be arranged by contractor

B1415.2 The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as described in the item. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn.

B1500 FENCING

B1501 GENERAL

B1501.1 The work comprises of fixing iron angles / struts and providing welded steel wire fabric fencing over masonry wall including necessary stays as shown in the drawing(s) and as directed by the Employer. The suitable foundation system (either Pile foundation or Strip foundation) for the boundary wall shall be decided by the Contractor based on his design to satisfy the design criteria.

B1502 IRON ANGLES / STRUTS

B1502.1 The iron angles / struts shall conform to relevant codes. The angle iron shall be embedded in cement concrete blocks 45x45x60 cm of mix 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size. Every 15th post, last but one end post and corner post shall be strutted on both sides and end post on one side only and struts embedded in cement concrete blocks 70x45x50 cm of the same mix. The angles / struts shall be fabricated and painted as per standard specifications.

B1503 BARBED WIRE

B1503.1 The barbed wire shall be of welded steel wire fabric and shall conform to IS: 4948. Welded steel wire fabric shall be fixed between the posts fitted and fixed with G.I. staples on wooden plugs or tied to 6 mm bar nibs with G.I. binding wire.

B1503.2 The barbed wire shall be of welded steel wire fabric and shall conform to IS: 4948. Welded steel wire fabric shall be fixed between the posts fitted and fixed with G.I. staples on wooden plugs or tied to 6 mm bar nibs with G.I. binding wire.

B1504 CONCERTINA COIL

B1504.1 Concertina coil (2.5+0.5) mm wire dia. with zinc coated 250gm/sqm, ultimate tensile strength 140-160 Kg/mm², Weight not less than 13Kg for 650 mm dia 80 no. of circles, 130 to 180 no of clips as per 304AISI with 1.5 mm thickness, 50mm thick 19 mm width strip with zinc coated 120gm/m².

B1600 MISCELLANEOUS

B1601 CRANE RAILS SYSTEM

B1601.1 Crane Rails

B1601.1.1 The specified crane rails shall be installed to the lines and levels shown on the Drawings. The details of the crane rail and crane rail fixing system as shown on the Drawings are indicative only and represent minimum requirements under the Contract.

B1601.1.2 The Contractor shall submit the details of proposed suppliers for the crane rail and crane rail fixing system for the Employer's approval. The crane rail shall be designed and installed and the detailed Crane Rail Fixing System shall be designed, supplied and installed by an approved Crane Rail Fixing System Supplier. The Crane Rail Fixing System Supplier shall provide a competent and experienced supervisor on Site who shall supervise the installation of each section of the crane rail in accordance with the Contractor's programme of works.

B1601.1.3 The Contractor and the Crane Rail Fixing System Supplier shall jointly and severally guarantee the completed Crane Rail System (which includes the crane rail and Crane Rail Fixing System) for a period of 20 years (10Years Design life + 10 Years Warranty).

B1601.1.4 The holding down bolts shall be cast in to the correct level +3mm and in the correct position + 3mm and less than 1° from vertical. Steel templates shall be provided by the Crane Rail Fixing System Supplier for this purpose. The rails shall be installed as per ISO:12488-1 Class 2 with following tolerance:

- (a) Vertical Tolerances :
Specified level $\pm 2\text{mm} / 2\text{ m}$ and $\pm 10\text{ mm}$ overall
- (b) Horizontal Tolerance :
Gauge $\pm 5\text{mm}$ maximum
- (c) Straightness : $\pm 1\text{mm}$ in 1.0 meter

B1601.1.5 Welding of rail joints shall produce a strength equivalent to the full section of rail using a Thermite welding process approved by the Employer. Crane rail welding shall comply with the requirements specified for structural steelwork elsewhere in these specifications.

B1601.1.6 Rail joints shall be vertical and square to the longitudinal axis of the rail. Joints shall not be located within 3m of any expansion joint in the supporting structure and shall be staggered between the pair of rails to dimensions detailed by the Crane Rail Fixing System Supplier such that only one wheel in adjacent pairs of bogies is on a joint at any one time.

- B1601.1.7 The crane rails shall be electrically continuous across all expansion joints in the rail, over their full lengths, as part of the lightning protection system. Electrical continuity shall be achieved by the use of approved conductors of minimum cross sectional area 70mm² or as indicated on the drawings. The connection to the rails shall be by fastenings welded to the crane rails. Each crane rail shall be connected to the earth pits as detailed on the Drawings.
- B1601.2 Crane Rail Fixing System**
- B1601.2.1 The Contractor shall appoint a Crane Rail Fixing System Supplier for Employer approval to design, supply, install and test the Crane Rail Fixing System.
- B1601.2.2 The Crane Rail Fixing System shall comprise holding down bolts, holding down bolt templates, base plate seating material, continuous base plates, continuous elastomeric pad rail seating, fixing clips, bolts and other necessary components for ISCR100 rails as per IS:3443,1980 or equivalent with Min Tensile Strength 710 MPa supporting the cranes.
- B1601.2.3 The Contractor shall follow the Crane Rail Fixing System Supplier's recommendations for installation.
- B1601.2.4 The fixings shall be designed to permit the rail to move longitudinally, but to restrain it from vertical and lateral motion so securely that stresses which result from the interaction between the concrete rail beam and the rail, including the "bow-wave" effect created by the crane while travelling, will be satisfactorily absorbed.
- B1601.2.5 A resilient interface between rail and the rail beam shall be provided so that rail and the rail beam movements can be accommodated without fatigue.
- B1601.2.6 The approved Crane Rail Fixing System Supplier shall provide a competent and experienced supervisor on Site who shall supervise the installation of each section of crane rail and the Crane Rail Fixing System in accordance with the Contractors programme of Works.
- B1601.2.7 The design of the Crane Rail Fixing System shall satisfy the performance requirements set out in the Specifications and Drawings and the requirements of the Crane Rail Fixing System Supplier. The contractor shall submit a written undertaking in this regard for approval of the Employer.
- B1601.2.8 No fabrication work shall be commenced before consent has been obtained from the Employer. The Contractor shall not be entitled to any extension of time for delays in the submission of a fully detailed design or due to such submissions being rejected by the Employer. Any consent by the Employer shall in no way relieve the Contractor or his Crane Rail Fixing System Supplier of their responsibilities for design and work under the Contract.
- B1601.2.9 The lateral adjustment in the rail available from the individual fixings will be minimum ± 5 mm but the workmanship of installation shall ensure that the rail has an available lateral adjustment capability of ± 5 mm i.e. total 10mm.

- B1601.2.10 The loads from forces transmitted to the crane rails are those generated by cranes. The maximum load generated by the crane envisaged to be installed on the jetty deck is mentioned in the crane specification. These loads are equivalent static loads which include allowance for dynamic and wind load effects as appropriate.
- B1601.2.11 Steel templates shall be supplied to locate the holding down bolts during concreting of the rail beam in such a manner as to achieve the specified accuracy.
- B1601.2.12 All bolt heads and nuts shall be hexagonal. Each bolt shall have at least one steel washer under the nut or bolt head, whichever is to be turned during tightening. Each bolt shall be tightened against a surface normal to the bolt axis and the washers shall therefore be tapered as necessary to meet this requirement. All bolts shall be tightened securely in the finished work and the length of each bolt shall be such that after tightening at least one complete thread projects beyond the outer face of the secured nut. Bolts, screws, lock nuts (if any) and nuts shall conform to the requirements of B.S. 4190.
- B1601.2.13 Locking nuts, neoprene washers or similar device shall be provided or the Crane Rail Fixing System Supplier shall demonstrate that the designed system prevents loosening of bolts under use of the rails by cranes.
A continuous resilient pad shall be provided between the crane rail and the base plate to:
- (i) distribute the crane wheel load;
 - (ii) reduce load concentrations and eliminate the resulting fatigue stresses;
 - (iii) provide an even contact between the rail and its bases;
 - (iv) reduce noise and vibration transmission.
- B1601.2.14 The resilient pad shall be manufactured from a synthetic elastomer. It shall be suitably resistant to wear, shear, crushing, as well as to action of oil, grease, sea water, ozone and ultra-violet rays. The elastomer shall conform to the following minima, or as appropriate to suit the specific details of the fixing system: -
- (i) Shore Hardness: $75^{\circ} \pm 5^{\circ}$ as per DIN53505
 - (ii) Breaking Stress: minimum 125 kg/cm² as per ASTM D412C
 - (iii) Elongation: minimum 250% as per ASTM D412 C
 - (iv) Permanent set: maximum 5% as per BS 903 Part A6
 - (v) Allowable compressive strain: 15%
- B1601.2.15 The resilient pad shall have a minimum thickness of 5mm and will be required to be in a service condition in the temperature range from 0°C to 60°C.

- B1601.2.16 Lateral pad stability shall be provided by the use of a high tensile steel reinforcing strip centrally bonded within the pad. The strip shall be galvanized and extend over a minimum of 60% of the pad width. At least one surface of the pad shall be fluted or grooved to provide a minimum compression of 5.0 percent under a uniform load of 100 kN/m.
- B1601.2.17 All cut edges of the pad shall be sealed in order to protect the steel reinforcement against corrosion.
- B1601.2.18 Rail clips shall be positioned in pairs along the rail. The type of clip and the spacing shall be designed by the Crane Rail Fixing System Supplier such that the following requirements are met:
- (i) allow for free longitudinal expansion and contraction of the rail due to temperature variation;
 - (ii) allow for a degree of vertical movement to accommodate the "bow-wave" effect;
 - (iii) allow for ± 5 mm lateral adjustment of the rail;
 - (iv) allow damaged rail to be removed at any time with ease;
 - (v) provide absolute lateral stability (no lateral "float") and capable of withstanding the lateral forces as specified;
 - (vi) rail clips and components shall be galvanized or otherwise similarly protected against corrosion in a severe marine environment;
 - (vii) when the rail clip fixing bolt is torqued to the manufacturer's recommendation, the whole assembly shall be self-locking and self-tightening.
 - (viii) should be capable of taking minimum 120kN Lateral Load per wheel
- B1601.2.19 Dimensions of the base plate shall be compatible with the rail, specified wheel loads, size of the rail recess and the method of installation.
- B1601.2.20 The base plate seating material shall be Non-Shrinkable Cement base grout that bonds the base plate to the concrete giving a strong continuous foundation base that is not affected by water or moisture and will not shrink.
- B1601.2.21 The base plate shall be installed in such a manner as to ensure that the rail installation tolerances given in this Section are satisfied. In addition, the level difference between abutting base plates shall be not greater than 1mm.
- B1601.2.22 The whole Crane Rail Fixing System including soleplates, holding down bolts, rail clips, bolts, washers and nuts shall be hot dip galvanized after fabrication to B.S. 729 or otherwise similarly protected against corrosion in a severe marine environment.
- B1601.2.23 The exposed areas of base plates, rail clip assemblies and holding down bolts shall be suitably coated with a waterproofing compound.

- B1601.2.24 The Contractor shall supply documentation from the manufacturer of each component of the Crane Rail Fixing System certifying that such items have been tested in accordance with the appropriate British or other equivalent internationally recognized standards and are suitable for the conditions and usage expected of the system. Such documentation shall be forwarded to the Employer for consideration prior to the dispatch of such components from the place of manufacture to the Site. Such certification shall not relieve Contractor of any liability for malfunction or deterioration of any component or inadequate performance of the Crane Rail Fixing System as a whole.
- B1601.2.25 The Contractor shall provide to the Employer at least 3 months prior to the due date for Substantial Completion a document detailing the routine maintenance required to be carried out during the period of the 20 year (10Years Design life + 10 Years Warranty). This document shall detail the frequency and extent of such routine maintenance work. The Crane Rail Fixing System Supplier shall carry out all routine maintenance required during the Maintenance Period. Immediately prior the expiry of the Maintenance Period for each Sectional Completion, the Crane Rail Fixing System Supplier shall ensure that all necessary routine maintenance has been completed and provide a certificate to that effect in a form acceptable to the Employer.
- B1601.2.26 The completed Crane Rail System shall meet and continue to meet all performance requirements stated in the Contract and otherwise be suitable in all respects for safe, efficient and continuous use under actual operating conditions for a period of not less than 20 years from the date of completion of the last Section to be completed subject to fair wear and tear and routine maintenance.

B1602 RUBBER FENDERS AND ACCESSORIES

B1602.1 General

- B1602.1.1 The Contractor shall supply and install rubber fender units to the jetty and FIC bay.
- B1602.1.2 Fenders shall be of the required types and rated capacities.
- B1602.1.3 In addition to fenders for berthing, suitable type edge fenders shall be provided at the corners of jetties, which are exposed to sea to protect vessels from hitting jetty structure accidentally.
- B1602.1.4 Fenders shall be proprietary units manufactured by a specialist marine bollard and mooring equipment manufacturer. The fender manufacturer shall demonstrate by way of project references a minimum of 10 years successful experience in the manufacture of rubber fender units and accessories of similar nature to those to be supplied under this Contract.

- B1602.1.5 All fenders shall be grey in colour and shall be given a unique serial number which can be traced back to the manufacturer's quality control and testing records.
- B1602.1.6 The fenders shall be supplied together with all the necessary frontal frames, resin facing pads, bolts, inserts chains, brackets, shackles and other accessories.
- B1602.1.7 The fixing details shown on the Drawings are indicative only and the Contractor shall install each element of the fender units including inserts, bolts, fender body, fender face, chains, brackets, shackles and other accessories, in accordance with the fender manufacturer's specific requirements for each type of fender.
- B1602.1.8 The supplier of the fenders should be actively involved in erection of fenders

B1602.2 Design Life

- B1602.2.1 To ensure maximum life and to minimize maintenance, all accessories and fittings shall be made of stainless steel grade 316 L and marine grade aluminium alloys.
- B1602.2.2 Values for the design life, and maintenance intervals, of various components of are presented in Table.

Element	Design Working Life (Years)	Maintenance Interval (Years)
Fenders and Fender Panels	30	15
Fender Chains and Fixings	25	15

- B1602.2.3 The Contractor shall submit O&M manuals, warranty details and the manufacturer's concurrence for the required design life for all fenders from the manufacturer.

B1602.3 Submittal Requirements

- B1602.3.1 The Contractor shall submit full details of the proposed fender units and accessories to the Employer along with associated calculations justifying the suitability of the proposed fenders and their distribution for the indicated use at the jetty for approval prior to the procurement of these items including but not limited to the following;
- (i) Details of the manufacturer and supplier of the unit including details of the manufacturers quality control system, evidence of project experience and statement regarding the suitability of the product in this application and its conformance to the requirements of the Specification;

- (ii) Shop drawings showing the general arrangement and principal dimensions of the unit including all the necessary frontal frames, resin facing pads, bolts, inserts chains, brackets, shackles and other accessories;
- (iii) Specifications detailing the features of the unit, the manufacturing or fabrication process, the materials used, requirements for installation and use and all relevant design or manufacturing standards or regulations;
- (iv) Rated Performance Data and PIANC Type Approval certificate for the proposed fender unit in accordance with the requirements of PIANC "Guidelines for the Design of Fender Systems: 2002: Appendix A";
- (v) Detailed calculations and analysis demonstrating the structural capacity of the steel frontal frames, chains shackles and accessories and associated hold down bolts and anchorages; and
- (vi) Where the frontal frames and accessories are proposed to be supplied coated in blue colour by the manufacturer, all details pertaining to the proposed coatings as specified for Protective Coating of Structural Steelwork in section B1200;
- vii) Warranty for fenders shall be specified and submitted to the employer.

B1602.3.2 The Employer's acceptance of the above submission shall be taken on the procurement of the item(s) to which the submission refers.

B1602.4 Fender Unit Performance Requirements

B1602.4.1 The Contractor shall provide the Rated Performance Data (RPD) and copy of current PIANC Type Approval certificate for the proposed fender units for testing in accordance with the requirements of PIANC "Guidelines for the Design of Fender Systems: 2002: Appendix A".

B1602.4.2 The allowable performance tolerance shall be $\pm 10\%$.

B1602.4.3 Each fender unit shall meet the minimum energy absorption and maximum reaction requirements as specified on the Drawings for;

- (i) RPD with the application of the manufacturers temperature factor corresponding to $+0^{\circ}\text{C}$; and
- (ii) RPD with the application of the manufacturer's temperature factor corresponding to $+39^{\circ}\text{C}$.

B1602.5 Fender Bodies

- B1602.5.1 Rubber fender units shall be compression moulded from natural or synthetic rubber or the mixture of both. The substance shall be reinforced with carbon black for resistance to ageing, abrasion, weathering, wearing and stability when repeatedly in contact with seawater.
- B1602.5.2 The rubber for fenders shall be homogeneous in quality, free from foreign materials, air bubbles, pores, injuries, cracks, defective impurities and other harmful defects.
- B1602.5.3 Steel plates shall be fully embedded and fully adhered to the rubber during the vulcanization process to avoid separation between the rubber and steel.
- B1602.5.4 The rubber for fenders shall comply with the specification stipulated below.

Property	Value	Test method & condition (Part No. of BS 903)
Density	1100 kg/m ³ to 1300 kg/m ³	Part A1
Hardness (International rubber hardness degrees)	≤72	Part A26 Method N
Tensile strength	≥16 N/mm ²	Part A2
Elongation change	≥ 350%	Part A2
After accelerated air ageing test: - Hardness (increase in IRHD) - Reduction in tensile strength - Reduction in elongation	≤ 8° ≤ 20% ≤ 20%	Part A19 Method A at 70°C x 96 hours
Oil resistance (measured by volume change percentage); - Industrial gasoline - Heavy oil	± 60% ± 20%	Part A16 Method A at 70°C x 96 hours
Compression set	≤ 30%	Part A6 Method A at 70°C x 22 hours using type 2 test pieces

Property	Value	Test method & condition (Part No. of BS 903)
Ozone resistance	No crack visible	Part A43 at 40°C x 100 hours
Tear resistance	≥ 60 kN/m	Part A3 Method C at 23°C
Abrasion resistance (volume loss at 3,000 revolution)	≤ 1500 mm ³	Part A9 Method C

- B1602.5.5 The fender body fixing bolts, washers and cast-in anchorages shall be stainless steel grade 316 / 316L complying with the requirements of either the relevant ASTM or BS EN standards governing the applicable method of fabrication / manufacture.
- B1602.5.6 Calculations demonstrating the adequacy of the fender anchorages shall be submitted to the Employer for approval. This shall include checking of concrete pullout (if applicable), edge failure or other concrete failure for all loads on cast in anchorages and fixings.
- B1602.5.7 All cast-in fixings or anchorages etc. shall be supplied with mill certificates or other certification in accordance with the applicable materials or manufacturing standards for the various items. The Contractor shall submit this certification to the Employer for approval prior to the installation of the cast-in items.
- B1602.5.8 The Employer acceptance of this submission shall be taken in advance, on the installation and casting in of these items.
- B1602.6 **Frontal Frames and Pads**
- B1602.6.1 All fenders units except pneumatic fenders shall be supplied with fabricated steel frontal frames and pads designed by the fender unit manufacturer to resist the reaction forces imposed by the fender and the supporting chains and accessories as necessary to ensure the fenders perform in accordance with the requirements of these specifications.
- B1602.6.2 The frontal frames shall be constructed to not less than the dimensions shown on the Drawings.
- B1602.6.3 Internal voids of sealed frames shall be completely filled with and approved non-reactive expansive foam with good adhesive properties or other approved material which will prevent the ingress of water in the event of the frame being punctured. Horizontal members of open frames shall be designed so that they are free draining.
- B1602.6.4 The frontal frames shall be manufactured from fabricated structural mild steel complying with the requirements of either the relevant ASTM, BS EN or IS standards governing the applicable method of fabrication. The grade of material under the nominated standards shall be nominated by the fender unit manufacturer to ensure the fenders perform in accordance with the requirements of these specifications.

- B1602.6.5 Steelwork in frontal frames shall be painted in accordance with the requirements of these specifications. Coatings may be either applied by the manufacturer or can be applied by the Contractor's specialist protective coating subcontractor but in either case shall fully conform to the requirements specified for Protective Coating of Structural Steelwork in section B1200.
- B1602.6.6 The frontal frames for front faces of arch type fenders shall be fitted with ultra-high molecular weight (UHMW) polyethylene or similar facing pads. The colour of the facing pads shall be black or as directed by Employer. The thickness of the pads shall be nominated by the fender unit manufacturer to ensure the fenders perform in accordance with the requirements of these specifications but shall not be less than 40mm. Corners and edges of the frontal frame shall be fitted with specialized chamfered pads. The coefficient of static friction of the pad material shall be less than 0.2 when measured in accordance with ASTM D-1894.
- B1602.6.7 Calculations demonstrating the adequacy of the frontal frame and pad design shall be submitted to the Employer for approval.
- B1602.7 **Support Chains, Fixings and Bolts**
- B1602.7.1 All fenders units shall be supplied with weight support, tension and shear chains and associated shackles, tensioners, chain brackets and U-anchors etc. as necessary to ensure the fenders perform in accordance with the requirements of these specifications.
- B1602.7.2 All such items shall comply with requirements for marine mooring or anchor chains complying with ASTM, BS EN or ISO standards or Bureau Veritas, DNV, American Bureau of Shipping certification requirements, Lloyds Register Anchor and Chain Cables Act or similar as nominated by the fender unit manufacturer. The grade of material under the nominated standards shall be nominated by the fender unit manufacturer to ensure the fenders perform in accordance with the requirements of these specifications.
- B1602.7.3 All non-stainless steel bolts, fixings, brackets, anchorages etc. shall be hot dip galvanized in accordance with BS EN ISO 1461.
- B1602.7.4 Calculations demonstrating the adequacy of all chains, shackles, fixings, bolts and anchorages shall be submitted to the Employer for approval. This shall include checking of concrete pull out or other concrete failure for all loads on cast in anchors and fixings.
- B1602.7.5 All cast-in fixings, anchorages or U-anchors etc. shall be supplied with mill certificates or other certification in accordance with the applicable materials or manufacturing standards for the various items. The Contractor shall submit this certification to the Employer for approval prior to the installation of the cast-in items.
- B1602.7.6 The Employer's acceptance of this submission shall be taken on the installation and casting in of these items.

B1602.8 Testing and Inspection

- B1602.8.1 The materials properties for fender rubber and UHMW-PE facing panels as specified in this section shall be certified by the fender unit manufacturer based on the results of regular production quality control testing on representative samples taken from each batch or lot from which the Contract fender units were manufactured. Any properties not subject to regular production quality control testing shall be sampled and tested specifically for the purposes of satisfying the requirements of this Contract. The actual test results shall be submitted along with the certification.
- B1602.8.2 Sample of fender shall be given to Employer for third party testing.
- B1602.8.3 All steel fabricated items, chains and associated shackles, tensioners, chain brackets and U-anchors, fender bolts and anchorages etc. shall be supplied with mill certificates or other certification in accordance with the applicable materials or manufacturing standards for the various items.
- B1602.8.4 All protective coatings shall be tested in accordance with and shall fully conform to the requirements specified for Protective Coating of Structural Steelwork in section B1200.
- B1602.8.5 In addition, the Contractor shall carry out energy/reaction compliance testing on each fender body to be supplied under this Contract in accordance with the requirements of "Guidelines for the Design of Fender Systems: 2002: Appendix A".
- B1602.8.6 Full details of the manner in which the supplier proposes to conduct this test shall be provided prior to testing.
- B1602.8.7 The Contractor shall provide the Employer with at least 28 days' notice of commencement of the above tests such that the Employer can make arrangements to witness the tests or to arrange for third party witnessing of these tests. The Contractor shall arrange for all necessary access to the manufacturer's testing facilities to be provided to the Employer or his delegate for this purpose.

B1603 PNEUMATIC FENDERS

B1603.1 Purpose

- B1603.1.1 This Specification defines the technical requirements for the pneumatic fenders for main jetty as shown in the drawings.
- B1603.1.2 This Specification covers the supply, testing and installation of fenders and associated fittings and fixtures.

B1603.2 General

- B1603.2.1 The technical requirements of this Specification are the absolute minimum acceptable. Where not specifically referenced herein, materials and workmanship shall comply with the latest edition and amendment of the applicable Indian Standard or approved International Standard.

B1603.3 Reference Documents

Standards/Codes

The following documents are referred to in this Specification:

ISO - 17357-1:2014(E)	Floating Pneumatic Fenders
ISO 37:2011	Rubber Testing - Tensile Strength and Elongation
ISO 188:2011	Rubber Testing - Aging Rubber Testing
ISO 815-1:2008	Rubber Testing - Compression Set
ISO 1431-1:2012	Rubber Testing - Static Ozone Aging Test
ISO 7619-1:2010	Rubber Testing - Hardness

B1603.4 Technical Standards

B1603.5 Fender Supply

- B1603.5.1 The pneumatic fenders shall be Grey colour. Each fender unit shall include at each end a steel end plate, ring, shackle, swivel and a second shackle, for connection to a steel chain, with a minimum diameter 22mm and appropriate end links. The end of the chain remote from the unit shall be connected to a recessed painted galvanized steel U-anchor via a steel shackle. The lengths of chain shall be such that the units are located at the levels shown on the Drawings.
- B1603.5.2 All steel shackles, swivels and chains shall be hot-dip galvanized (130 microns).
- B1603.5.3 The fenders will be suspended at low tide states except the higher tides, when they will be floating.
- B1603.5.4 The fender units are to be supplied by an approved manufacturer. The manufacturer shall produce documented evidence of the satisfactory performance of at least two installations using similar size pneumatic units over at least a ten year period in a similar climatic environment and exposure to this project.
- B1603.5.5 The Contractor shall submit for approval the energy/deflection and reaction/deflection curves for the unit proposed, up to a maximum deflection of 60% and suitability of the fenders and their disposition for the indicated utilization for the jetty. The expected manufacturing tolerances for the fender characteristics given on the curves shall be as per ISO 17357-1:2014.
- B1603.5.6 All fenders shall be designed, manufactured, inspected and tested to ISO – 17357-1:2014 (E).

B1603.6 Fender Harnessing

B1603.6.1 Appropriate chain Tire and sleeve harnessing to be provided to protect the fenders. The rubber should be of Grey colour.

B1603.7 Inspections and Testing

B1603.7.1 The following inspections and testing shall be carried out:

(a) Dimensional Inspection

B1603.7.2 The dimensions of all fenders shall be inspected at the initial internal pressure of 50kPa and the results shall be within the tolerances below:

Dimensions	Tolerances
Length	+10%, -5%
Diameter	+10%, -5%

B1603.7.3 The diameter shall be obtained based on the average of at least two different measurements taken at the middle of the cylindrical section of the fender.

(b) Rubber Material Test

B1603.7.4 Testing of the outer rubber and the inner rubber shall be conducted in accordance with the specifications given below. The results shall satisfy the requirements given.

Test Item	Test Method	Required Value	
		Outer Rubber	Inner Rubber
1. Before aging:	-	-	-
a) Tensile strength MPa	ISO 37:2011	18 or more	10 or more
b) Elongation	ISO 37:2011	400 or more	400 or more
c) Hardness	ISO 7619-1:2010	60 ± 10 (Durometer hardness Type A)	50 ± 10 (Durometer hardness Type A)
2. After aging:	ISO 188:2011	Air oven aging, 70 ± 1, 96 hours	Air oven aging, 70 = 1, 96 hours
a) Tensile strength	ISO 37:2011	Not less than 80 of the original property	Not less than 80 of the original property
b) Elongation	ISO 37:2011	Not less than 80 of the original property	Not less than 80 of the original property
c) Hardness	ISO 7619-1:2010	Not to exceed the original property by more than 8	Not to exceed the original property by more than 8

Test Item	Test Method	Required Value	
		Outer Rubber	Inner Rubber
3. Tear	ISO 34-1:2010	400 N/cm or more	No requirement
4. Compression set	ISO 815-1:2008	30% (70 ± 1°C; 22 hours) or less	No requirement
5. Static ozone aging test	ISO 1431-1:2012	No crack after elongated by 20% and exposed to 50pphm x 40°C x 96 hours	No requirement

(c) Air Leakage Test

The air leakage test shall be conducted on all the fenders at the initial pressure of 50kPa for more than 30 minutes and test results shall confirm that there is no air leakage.

(d) Hydraulic Pressure Test

The hydraulic pressure test shall be performed for 10 minutes at the hydraulic pressure of 250kPa and there shall be no leakage of water and no defects during the test.

Frequency of the test shall be one per 20 fenders supplied.

Circumferential and longitudinal length shall be measured at 10kPa pressure and at the test pressure of 200kPa. The temporary elongation shall be as follows:

- Maximum circumferential temporary elongation: 10%
- Maximum longitudinally temporary elongation: 10%

$$\text{Temporary elongation} = \frac{\text{Length increase at 200kPa}}{\text{Length at 10kPa}} \times 100$$

Length at 10kPa

The increase in diameter and length shall be obtained by measuring the distance of two points marked circumferentially and longitudinally at 10kPa pressure onto the middle of the fender's body. The distance between the two points shall be larger than one fifth of the fender's diameter.

(e) Performance Tests

One per 20 of the actual size supply pneumatic fender units shall be performance tested(Parallel Compression Test). Each unit to be tested shall be progressively loaded at a rate not exceeding 80mm/minute normal to its face till the energy absorption reaches the GEA (Guaranteed Energy Absorption), with reaction force and deflection being measured at least every 5% deflection. The height recovery within 5 minutes after the compression test shall be at least 98% of the original height, prior to any testing.

The test shall be repeated twice with an interval of 5 min. between the two tests. The energy absorption and reaction shall be obtained from the mean value of the two test records. A fender meets the required GEA performance if it achieves 100% of its GEA energy absorption without exceeding 65% deflection and 110% of its GEA reaction.

B1603.8 Marking

B1603.8.1 Each fender shall have markings on the fender body to indicate the following information:

- ISO standard number, and applicable year, i.e. ISO 17357 2014
- Size (diameter and length)
- Initial internal pressure
- Date of manufacture or its abbreviation
- Full or abbreviated name of manufacturer e Individual serial number
- Type of reinforcement layer

B1603.8.2 Markings of manufacturer, internal pressure rating and size shall be in suitable size and finish to enable clear identification. Letter height of these shall be minimum 100mm

B1603.9 Installation

B1603.9.1 The fenders complete with Tire & sleeve, chains and shackles shall be installed by the Contractor in accordance with the approved Drawings by Employer. Connection to the structures shall be through SS316 U-anchors.

B1603.10 Documentation

B1603.10.1 The Contractor shall provide, at least four weeks prior to shipping of the units, to the Employer certification that fenders have been tested and inspected as required by the Specification, and that all requirements have been met, together with a test and inspection report as well as material certificate of the synthetic tire cord used for the fenders supplied.

B1603.10.2 The Contractor shall provide an Operating and Maintenance Manual, which shall include a logbook, where details of all maintenance and repairs carried out on the fender from the date of installation can be recorded.

B1603.10.3 The Manual shall cover specific technical information relating to serial number, age, initial pressure, safety valve specification etc. together with recommendations regarding handling, storage, packing, installation, repairs, testing, inspections and maintenance.

B1603.11 Accessories

B1603.11.1 The following accessories shall be provided by the Contractor, for each group of 10 No. fenders, in accordance with the recommendations of the manufacturer, subject to the approval of the Employer.

B1603.12 Spare Parts

- 1 pc Spare valve (air valve)
- 1 pc Box spanner for removing air valve
- 1 pc Air pressure gauge with air chuck
- 1 pc Air filling hose with air chuck (10m)
- 1 pc Valve core screw driver

B1603.13 Repair Material

- 1 sheet Rubber sheet (1.0m x 0.5m)

B1603.14 Repair Tools

- 1 pcs Brush
- 1 sheet Sand paper
- 1 pc Hand roller

B1604 BOLLARDS

B1604.1 General

B1604.1.1 The Contractor shall supply and install bollards to jetty and FIC bay in accordance with the details shown on the Drawings.

B1604.1.2 Bollards shall be of the required types and rated load capacities.

B1604.1.3 Bollards shall be proprietary units manufactured by a specialist marine bollard and mooring equipment manufacturer. The bollard manufacturer shall demonstrate by way of project references a minimum of 10 years successful experience in the manufacture of ductile iron mooring bollards of similar nature to those to be supplied under this Contract.

B1604.1.4 Capacity of bollard shall be indicated in legible font either on top or side of the bollard.

B1604.2 Materials

B1604.2.1 Bollards shall be manufactured from ductile cast iron (also known as spheroidal graphite cast iron) complying with the requirements of either ASTM A536 or BS EN 1083 or equivalent. The grade of material under either of the nominated standards shall be nominated by the bollard manufacturer.

B1604.3 Design Life

B1604.3.1 To ensure maximum life and to minimize maintenance values for the design life, and maintenance intervals, of various components of are presented in table given below:

Element	Design Working Life (Years)	Maintenance Interval (Years)
Bollards and Cleats	50	15

B1604.3.2 The Contractor shall submit O&M manuals, warranty details and the manufacturer's concurrence for the required design life for all bollards from the manufacturer.

B1604.4 Design Requirements

B1604.4.1 Load capacities shown on the Drawings indicate the minimum safe working load capacity or rated load capacity of the bollard and shall be applicable to loading angles within 180 degrees of the wharf cope line alignment in the horizontal plane and within the range -10 degrees to +70 degrees from horizontal in the vertical plane.

B1604.4.2 The Contractor shall submit details of the proposed bollard / assembly and associated anchorage system with calculations and analysis demonstrating that the following minimum factors of safety (on the un-factored safe working load and un-factored capacities) are achieved under the most severe load case(s);

- (i) 3.0 on yield of cast-in hold down bolts;
- (ii) 2.5 on ultimate failure of bollard baseplate and body/stem;
- (iii) 1.66 on yield of bollard baseplate and body/stem;

B1604.4.3 Design calculations shall be supplemented with finite element analysis results for irregularly shaped items for which representative hand calculations cannot be accurately performed. The calculations and analysis shall be prepared and certified by a chartered professional structural Engineer conforming to the requirements specified for the Contractor's Designer in the Specification before Employer's approval submission.

B1604.5 Protective Coatings

B1604.5.1 Bollards shall be painted in accordance with the requirements of these specifications. Coatings may be either applied by the manufacturer or can be applied by the Contractor's specialist protective coating subcontractor but in either case shall fully conform to the requirements specified for Protective Coating of Structural Steelwork in section B1200.

B1604.6 Hold-down Bolts and Anchorage Details

B1604.6.1 The cast in anchorage and hold down bolt details shown on the Drawings are indicative only. Cast in anchorage and hold-down bolt details shall be strictly in accordance with the requirements of the manufacturer.

B1604.6.2 Hold down bolts, cast in plate washers or anchor plates, and all other fasteners shall be minimum ISO 898-1 Grade 8.8 or equivalent and hot dip galvanised in accordance with BS EN ISO 1461.

B1604.6.3 All fittings including bolts, nuts, washers shall be tested and certified in accordance with the relevant materials standards. All relevant materials tests results and certificates shall be supplied with the hold down bolts and anchorage accessories and shall be submitted to the Employer for approval prior to the installation of the hold down bolts.

B1604.6.4 The Employer acceptance of this submission shall constitute a HOLD POINT on the installation and casting in of the hold down bolts.

B1604.6.5 The Contractor shall install the hold down bolts strictly in accordance with the manufacturer's specific requirements for each type of bollard. A temporary plywood template shall be used at the top of the bolts to prevent movement or dislocation during concreting.

B1604.6.6 The exposed ends of the bolts shall be coated with an approved petrolatum paste and wrapping tape upon completion of the bollard installation and tightening of the bolts to prevent corrosion and facilitate the future removal of the bollard if necessary.

B1604.7 Grouting of Base Plates

B1604.7.1 The Contractor shall install each unit in accordance with the supplier's specific requirements for each type of bollard. The clear gap between the underside of the baseplate and the top surface of the concrete deck shall be as specified by the bollard unit manufacturer.

B1604.7.2 Following installation and levelling of each bollard unit and tightening of the hold down bolts, the Contractor shall grout the baseplates so as to completely fill the void between the underside of the baseplate and the top surface of the concrete deck.

B1604.7.3 The grout shall be an approved free flowing, high strength cementitious grout, Fosroc "Conbextra HF" or equivalent.

B1604.7.4 The grout shall be shrinkage compensated by way of volumetric expansion of the grout in the plastic state as well as formulated to compensate for longer term expansion in the hardened state. The compressive strength of the grout must exceed 60MPa at 28 days. The storage, handling, placement and curing of the grout shall be strictly in accordance with the manufacturer's instructions.

B1604.7.5 **Markings on Bollard:** Each casting shall be legibly marked with Capacity of Bollard in projected bold letters with letter size not less than 100mm (**90T**)

B1604.8 **Submittal Requirements**

B1604.8.1 The Contractor shall submit full details of the proposed bollard to the Employer for approval prior to the procurement of these items including but not limited to the following;

- (i) Details of the manufacturer and supplier of the unit including details of the manufacturers quality control system, evidence of project experience and statement regarding the suitability of the product in this application and its conformance to the requirements of the Specification;
- (ii) Warranty for bollards shall be specified and submitted to the employer.
- (iii) Shop drawings showing the general arrangement and principal dimensions of the item including the hold down bolt layout and anchorage arrangement; Scale sketches demonstrating that the proposed hold down bolt arrangement can be installed without compromising the requisite concrete reinforcement at the installation location, including illustration of any proposals for localised displacement of reinforcement as may be required;
- (iv) Specifications detailing the features of the unit, the manufacturing or fabrication process, the materials used, requirements for installation and use and all relevant design or manufacturing standards or regulations;
- (v) Detailed calculations and analysis demonstrating the structural capacity of the unit and the hold down bolts with reference to the specified safe working load and the requisite factors of safety; and
- (vi) Where the units are proposed to be supplied coated by the manufacturer, all details pertaining to the proposed coatings as specified for Protective Coating of Structural Steelwork in section B1200;

B1604.8.2 The Employer's acceptance of the above submission shall constitute a HOLD POINT on the procurement of the item(s) to which the submission refers.

B1605 LADDER

B1605.1 Design Life

B1605.1.1 To ensure maximum life and to minimize maintenance, all accessories and fittings shall be made of stainless steel grade 316. The values for the design life and maintenance intervals of various components are presented below:

Element	Design Working Life (Years)	Maintenance Interval (Years)
Ladders and Curbs	50	10

B1605.1.2 Rubberized stainless steel ladder shall be provided on the structure for the access. The ladder shall be provided with stringer / foot holds having shock absorption & shape restoration characteristic. The contractor shall submit manufacturer catalogue for approval and satisfy the Employer about its performance.

Description	Material
Stringer	Rubber & SS 316
Rung	Rubber & SS 316
Mounting Bracket	SS 316
Resin Anchor Bolt	SS 316
Ladder Fixing Bolt	SS 316
Hand Grip (Pipe)	SS 316
Hand Grip Plate	SS 316
Plate Fixing Bolt	SS 316
Rung Fixing Nut & Washer	SS 316

B1606 STAINLESS STEEL MOORING RINGS

B1606.1.1 Mooring rings shall be made from 32 mm dia. SS316 grade stainless steel bars with an inner diameter of 150mm. 32 mm dia eyebolts shall be SS316 grade, which shall be used for fixing mooring rings.

B1607 RUBBING STRIP

B1607.1.1 'D'type rubber fender of sizes 150mm H x 150mm W (overall) shall be provided at all bollard locations. The rubber used for manufacturing rubber fender shall be as per ASTM-D-2000-98c. Necessary test certificates, chemical composition of rubber tested in a NABL approved laboratory shall be produced by the contractor.

B1608 HANDRAIL POSTS AND HANDRAILS

B1608.1.1 SS 316 handrails with toughened glass etchings shall be provided for building staircase.

B1608.1.2 Handrail posts and handrailing shall be fabricated from medium class stainless Steel Tubes conforming to ASTM A312, ASME SA312 (SS 316 grade).

B1608.1.3 RCC handrails shall be provided along Approach Trestle. Finished concrete shall be free of cracks, spalls, honey combing, or other defects, and exposed vertical and top surfaces shall be given a rubbed surface finish. Micro silica may be used in the concrete to be used for handrails.

B1609 DRAIN HOLES

B1609.1.1 For main jetty, approach and FIC bay, the Contractor shall provide drain holes in the deck to drain surface water as shown in the drawings. Drain holes shall be by CPVC pipes through the deck.

B1610 EDGE ANGLES

B1610.1.1 Stainless steel of SS316 edge angles shall be provided, wherever required.

B1611 CRANE CABLE PROTECTION SYSTEM

B1611.1 General

B1611.1.1 The cable protection system shall consist of a special reinforced rubber belt and pre-formed interlocking stainless steel channel designed to safely protect the power cables while allowing vehicular traffic to drive over it.

B1611.2 Reinforced Belt (Other than Road Crossing)

B1611.2.1 The channel cover shall be a high quality flexible rubber steel cord and nylon reinforced Standard Panzerbelt PB 400 series or equivalent.

B1611.2.2 The channel cover shall be a flexible reinforced rubber belt able to resist stresses caused by vehicles passing across channel. It must be able to support a load equivalent to 800 N/cm² across a 100 mm wide channel slot without damage. It shall be composed of:

- 80% Styrene Butadiene Rubber

- 15% Steel Cord
- 5% Nylon synthetic fibres

B1611.2.3 The belt reinforcement shall consist of two layers of reinforcement as follows:

Two layers of steel cord over the cable slot area and one layer of steel cord in the hinge area, each comprised of:

- Longitudinal cords of RFL dipped nylon yarn rated to a breaking load of 50 daN/cm.
- Transverse cords of brass coated steel rated to a breaking load of 640 daN/cm.

B1611.2.4 The reinforcement shall render the belt inflexible only in the transverse direction with the exception of the hinged area. The belt shall remain sufficiently flexible lengthwise to allow the necessary lifting performance of the belt during reeling up and depositing of the cables.

B1611.2.5 The belt layers shall be assembled by a hot vulcanization process incorporating highly abrasion resistant rubber compounds on the external surfaces and high adhesion rubber compounds adjacent to the steel cord layers. The belt shall be fixed to the channel with hot dip galvanized steel strips. The strips shall be located in a recess, molded into the belt and fixed with 5 mm diameter pop-rivets; a minimum of 13 rivets per meter shall be used for the fixing. The rivet heads shall remain below the surface of the fixing strips in pre-drilled countersunk holes.

B1611.2.6 The belt shall have a series of longitudinal grooves, molded in the upper edge adjacent to the fixing strips to act like a hinge and ensure the belt will open and close efficiently and adequately return to a horizontal resting position after being lifted.

B1611.2.7 Belt splices shall be supplied with each length of belt and shall be hot dip galvanized or stainless steel and fastened with pop rivets.

B1611.2.8 The belt shall be furnished in approx. 50 m lengths to allow efficient handling and installation.

B1611.3 **Reinforced Belt (At Road Crossing)**

B1611.3.1 The channel cover shall be a high quality flexible rubber steel cord and nylon reinforced Super Panzerbelt SPB400 series or equal for heavy traffic loading.

B1611.3.2 The belt reinforcement shall consist of four layers of reinforcement as follows:

Two layers of steel cord over the cable slot area and one layer of steel cord in the hinge area, each comprised of:

- Longitudinal cords of RFL dipped nylon yarn rated to a breaking load of 50 daN/cm.

- Transverse cords of brass coated steel rated to a breaking load of 640 daN/cm.

Two layers of specially woven RFL dipped synthetic fibres located between the steel cords and continuing completely through the hinge area, each comprising:

- Longitudinal cords of polyester yarn rated to a breaking load of 160daN/cm (915 pounds/in).
- Transverse cords of nylon yarn rated to a breaking load of 55daN/cm (315 pounds/in).

B1611.3.3 The reinforcement shall render the belt inflexible only in the transverse direction with the exception of the hinged area. The belt shall remain sufficiently flexible lengthwise to allow the necessary lifting performance of the belt during reeling up and depositing of the cables.

B1611.3.4 The belt layers shall be assembled by a hot vulcanization process incorporating highly abrasion resistant rubber compounds on the external surfaces and high adhesion rubber compounds adjacent to the steel cord layers.

B1611.3.5 The belt shall be fixed to the channel with hot dip galvanized steel strips. The strips shall be located in a recess, moulded into the belt and fixed with 5mm dia. stainless steel rivets at ~ 75 mm intervals. The rivet head shall remain below the surface of the fixing strips in pre-drilled countersunk holes.

B1611.3.6 The belt shall have a series of longitudinal grooves, molded in the upper edge adjacent to the fixing strips to act like a hinge and ensure the belt will open and close efficiently and adequately return to a horizontal resting position after being lifted.

B1611.3.7 Belt splices shall be supplied with each length of belt and shall be hot dip galvanized and fastened with stainless steel rivets.

B1611.3.8 The belt shall be furnished in approx. 50 m lengths to allow efficient handling and installation.

B1611.4 **Steel Channel**

B1611.4.1 The channel shall consist of pre-formed stainless steel interlocking sections that will be embedded in concrete.

B1611.4.2 Channel sections shall be manufactured from 1.5 or 2.0 mm thick stainless steel (AISI 316) in appropriate section lengths, as determined by the manufacturer, to minimize cost and maximize ease of construction. Channel sections shall be self-anchoring and reinforced in the belt securing area.

B1611.4.3 Channel sections shall incorporate an interlocking feature to provide a positive engagement from one channel section to the next thus ensuring no sharp edges that would interfere with or damage the cable during reeling operations.

- B1611.4.4 The channel shall be pre-drilled along the hinge area to simplify the installation of the belt. The manufacturer shall supply a method of locating the pre-drilled holes during belt installation.
- B1611.4.5 Each channel section shall be electrically connected to the other along both sides with copper grounding strips.
- B1611.4.6 A pre-formed stainless steel cable stand shall be supplied to protect the cable from debris and to allow adequate drainage.
- B1611.4.7 The channel sections shall be supplied fully assembled and are to include a high density (min 15 kg/m³) polystyrene cable slot filler to maintain channel geometry during shipment and installation.
- B1611.5 **Performance**
- B1611.5.1 The manufacturer shall provide a written five (5) year warranty against defects in materials or workmanship. Warranty shall commence upon substantial completion of the project or when the facility is first placed into service, whichever occurs first.
- B1611.5.2 The manufacturer shall have a minimum of ten similar successful installations, each in service for over five years.
- B1611.5.3 The reinforced belt shall be capable of opening a minimum of 90° by way of a specially developed hinge area and the belt shall always return to a flat horizontal resting position after being opened.
- B1611.5.4 The belt shall have an anticipated life in excess of 250,000 opening cycles.
- B1611.6 **General**
- B1611.6.1 The manufacturer shall provide a representative, directly employed by the manufacturer and personally familiar with the system, to provide training to the installation contractor prior to beginning the installation.
- B1611.6.2 The manufacturer's representative shall be made available, as required, during construction to ensure the system is installed according to the manufacturer's recommendations.
- B1611.6.3 The manufacturer shall provide written installation procedures for use by the installation contractor.

LIST OF APPROVED MANUFACTURERS / VENDORS

Civil & Structural

S. No.	Description /Material	Manufacture's Name
1	Cement	Ultratech, Birla, ACC, Malabar Cement, Ambuja, Dalmia, Penna, Coromandel
2	Reinforcement Bars	TATA, SAIL, RINL, JSW, JSPL, Shyam Steel
3	Structural Steel	TATA, SAIL, RINL, JSW & JSPL
4	Mechanical Splicing Couplers	Dextra, Bartec, Lenton, Dayton superior & JB rebar couplers
5	Fly ash	Thermal plants, ashcrete, Ultra Pozz & Star Pozz or equivalent
6	Micro Silica	Sika, Elkem, FOSROC, MAPEI, Corniche
7	Admixtures for Concrete	BASF, FOSROC, Sika, Eurobuild Construction Chemicals & Coating, MYK Schomburg
8	Ceramic Tiles	Kajaria, Belli Johnson, Nitco, Somany, Orient, H&R Johnson Pvt Ltd, Regency Ceramics Ltd.
9	Vitrified Tiles	Kajaria, Somany, Nitco, Simpolo & Varmora
10	Heavy Duty Vitrified Tile	Kajaria world, Nitco, Somany, Asian, RAK, Orient Bell or equivalent
11	Heavy Duty Chequered Tile	NITCO, Modern Tiles, Hindustan Tiles, Super Tiles & Marble Pvt Ltd or equivalent
12	Glass Mosaic Tiles	Mridul Enterprises, Krishna, Italia, Bisazza, Kenzai, Opio & EON, Palladio
13	Marble blended Vinyl Tiles/Sheet	Armstrong of Inarco Ltd, Terkett Floorings, Krishna Vinyl or equivalent
14	Marble Mosaic Tiles	Nitco, Basant Tiles, Asian Granito India Ltd AGL Tiles, H&R Johnson or equivalent
15	Porcelain Tiles	Century Tiles Ltd, Kajaria World, ROCA, Dura-tiles or equivalent
16	Yellow Tactile Tiles	Pelican ceramics, Uni Stone Products (India) Pvt Ltd, Nimco Prefab Ltd, Johnson, Automark technologies India Pvt Ltd or equivalent
17	Epoxy Flooring	Fosroc, STP Ltd, Cera-chem, Don Chemicals, Eurobuild construction chemicals & coating, Pidilite

S. No.	Description /Material	Manufacture's Name
18	METHYL METHACRYLATE COATING (MMA)	Flawcrete, Silikal, Sika, Dur-a-flex or equivalent
19	Tile Adhesive /Epoxy Grout	Ardex Endura (India) Pvt. Ltd, MYK Laticrete, Kerakoll India Pvt. Ltd, Eurobuild Construction Chemicals & Coating, Bostik, MAPEI BASF, Pidilite, Sunanda Speciality Coatings Pvt. Ltd, Kunal Conchem Private Ltd
20	Epoxy chemical for anchoring grout	HILTI, Fisher, Euro Build, Dubond, Pidilite or equivalent
21	Chemical /Mechanical Anchor Fasteners	HILTI, Fisher, MKT (Germany), Black and Decker India Ltd., MAPEI, SS Fasteners Pvt. Ltd
22	MS Tubes	Tata, Lloyd Metal & Engineering Co./ NSL Limited, Bihar Tube Ltd, Swastik Pipes Ltd, ISPAT, Hi tech Pipes,
23	Modified Bituminous Membrane Multiplas Standard of Integrated Waterproofing membrane Roof Water Proofing	"Multiplas Standard" of Integrated Waterproofing Membrane Ltd /"SUPER THERMOLAY"/ "POLYFLEX" of STP limited, "LOTUS-3" of the Structural Waterproofing Co.Limited /"HEAVY DUTY POLYPLY" of Ana Roofings Private Limited, Apple chemie, Shell, Hincola or equivalent
24	P.V.C membrane for water proofing of base slab & sidewall	Sikaplan WP, Renolit, FOSROC, BASF or equivalent
25	Tile Joint Filler	Bal Adhesives & Grouts, "Roff Rainbow Tile Mate" of Roff Construction Chemicals Pvt Ltd, Winsil 20/Silicon Sealant of GE Bayer Silicon, "Zentrival FM"of MC-Bauchemie (India)Pvt Ltd, Laticrete, BASF
26	Epoxy Putty	Techoxy By Choksey Chemicals Pvt. Ltd., Toyo Ferrous Crete (P) Ltd, H.C Associates, Apple chemie or equivalent
27	Polysulphide Sealants	Pidilite Industries Ltd., BASF, FOSROC, STP, SIKA, Fairmate, Apple chemie, Choksey
28	Silicone Sealants	G.E Bayer Silicone, Dow Corning, Wacker, Sika, McCoy Soudal or equivalent
29	Sealant Joints	"Silpray" of G.E Bayer Silicone, Watson Bowman Acme Corporation or equivalent

S. No.	Description /Material	Manufacture's Name
30	Emulsion Paints	ICI, Dulux Velvet, Luxol silk, Johnson & Nicholson, Modi Industries Ltd. (paint section), Acro Paints Ltd, Asian, Berger, Nerolac, SKK
31	Synthetic Enamel	ICI Dulux, Giossl Berger, Modi Industries Ltd. (paint section), Acro Paints Ltd, Asian, Nerolac,
32	Textured Paints	Spectrum, Unitile, TEXFIN Products (M/s NIKO), Acro Paints Ltd, Birla, ICI Dulux, Surfa
33	Polyurethane Paint	MRF, NEROLAC, TEXFIN products (M/s NIKO), H.C Associates, Modi Industries Limited (Paint Section), The Chemicals of India, Berger
34	Anti-Termite Paint	PIDILITE, Indigo Paints, Wood care, Wood Guard or equivalent
35	Water Proof Cement paint	Super Snowcem, Acro, Berger, Nerolac, Sika or equivalent
36	Paints	Berger, Johnson & Nicholson, Nerolac, Asian, Jotun
37	Fire resistant paints	Akzo Noble, Berger, PPG, Jotun, Navair, S.V.Coatings Pvt. Ltd., or equivalent
38	Acrylic Emulsion	Berger, Apex, Johnson & Nicholson, Nerolac, Jotun
39	Wax Polish	Reckitt & Colman, Asian, Berger or equivalent
40	Clay Tile Cladding	BTC, Wienerberger, Argeton, Affatiles, SLJ, GEE Tiles
41	Melamine	ICI Dulux, Timberstone Melamine Coating, Asian, Berger or equivalent
42	PU coat	Esdee, Pidilite, CIPY Polyurethanes Pvt Ltd, MYK Schomburg, Sunanda Speciality Coatings Pvt. Ltd, Kunal Conchem Private Ltd
43	Silicon Water Repellant Solution	GE Bayer Silicon Pvt Ltd / Metro ark Private Limited or " Silicon Waterpeller" by STP Limited," Nisiwa-SH" of MC-Bauchemnic (india) Pvt. Ltd/"Techrepel" of Choksy Chemicals Pvt. Ltd, The Chemicals of India"
44	Raised (Access) Floor with assembly system	Hewetson, United Access Floor United Insulation, Acon Pan I Unifloor Uniflair, Mis. Pallium marketing Pvt. Ltd. Multifloors, Proactive Systems
45	Pressed Steel Door & Frames	Agew steel manufacturers Pvt. Ltd., SenHarvic, Sat jail Raymus, Sehgal & Sehgal Industries or equivalent

S. No.	Description /Material	Manufacture's Name
46	Rolling Shutter	Popular, Gandhi Automation Pvt. Ltd, Falcon, Jacob Engineering or equivalent
47	Ball bearings	SKF, FAG, TATA, Timken, KOYO or equivalent
48	UPVC Door/Windows/Ventilators	Fenesta Building System, Aparna venster, Adopen India, Lingel windows and doors Technologies Pvt Ltd, Prominace
49	Fire Door	Signum, Shakti Met, Godrej, Radiant, pacific, Global Fire Protective Agency
50	Steel doors /windows	Shakthi hormann, Indigatech, Ozone Overseas Pvt. Ltd, NCL Alltek & Seccolor Ltd, Kutty Flush Doors & Furniture Co. Pvt. Ltd, Madhu Industries or equivalent
51	F.R.P Doors	Everest composite Pvt. Ltd, Capello Industries, Fibertech composites, EP Kamat Group or equivalent
52	Flush door	Samrat, Kanchan prima Swastick, kutty, Diamond, Raveela, Alpro.1, Decorative Duroply
53	Aluminium Doors and windows	Sehgal & Sehgal Industries, AJIT India (Madras) Ltd., or equivalent
54	Glazed Doors / Automatic Bi-Parting Sliding Door	Dorma GMBH & Co. KG, Kaba Gilgen SA, Geze GmbH or equivalent
55	Door Fitting, S.S. door handles, heavy duty door closures etc	Dorma, Hafele, Dorset, D-line, Shanu (India) products Pvt. Ltd.
56	Glazed Doors with patch fittings	Dorma, Ozone Overseas Pvt. Ltd, ASSA ABLOY India Private Ltd., Dorset Kaba Security Systems Pvt. Ltd. or equivalent
57	Door hardwares	Dorma, Ozone Overseas Pvt. Ltd., Dorset, Kaba Security Systems Pvt. Ltd., ASSA ABLOY India Pvt. Ltd., Hafele, Godrej, Everite Agencies, Dyna, Door king, Hettich India Pvt. Ltd
58	Mortice locks, locks, latch	Godrej, Dorset, Kaba Security Systems Pvt. Ltd., Magnum, Ozone Overseas Pvt. Ltd, Dorma or equivalent
59	Auto Closer Hinges	Blum, Hafele, Ozone Overseas Pvt. Ltd or equivalent
60	Draw sliders	Blum, Mepla, Grass, Ozone Overseas Pvt. Ltd, Hafele, Hettich India Pvt. Ltd

S. No.	Description /Material	Manufacture's Name
61	Patch Fittings	Dorma, Savex, Niki, Ozone, D-line
62	High Performance Glass / Clear Glass/Reflective glass	Saint Gobain, ASAHI India Glass Ltd, Nippon sheet Glass Co. Ltd., Emirates Glass L.L.C or equivalent
63	Insulation	UP TWIGA Fiber glass ltd., Lloyd, Owens Corning, Paramount, Rockwool
64	EPDM Gaskets	Osaka Rubber Private Limited, AMEE Rubber Industries Pvt. Ltd, Creative elastomers or equivalent
65	Aluminium Composite Panel	Alucobond, Reynobond, Alpolic, Alcotex, Alcopanel,
66	Frameless Glass Partition Fixtures	Dorma, Hafele, Dorset, Dline, Shanu (India) products Pvt. ltd
67	Epoxy Grouts	Laticrete, Toyo Ferrous Crete (P) Ltd, FOSROC, SIKA QUALCRETE, Araldite, Acro Paints Ltd
68	Epoxy polyester Resin for fixing anchor in soffits	Lok Set' of Fosroc Chemicals, STP, MBT or equivalent
69	Laminate	Decolam, Greenlam, Formica, Sandek, Bakilite Hylam Ltd
70	Vinyl Tile	Armstrong, Terkett Floorings, Krishna Vinyl or equivalent
71	Stone Cladding clamps	HILTI, Fischer, Canon, Axel or equivalent
72	Anchor Fastener	HILTI, FISHER, Canon, Pooja Forge, AXEL Industries
73	Ceramic glazed Mosaic Tiles	Kenzai Ceramics, Raja Tiles, Hindustan Tiles, Italia, Kajaria, Nitco
74	Sanitary and Bath Fittings such as normal pillar cock, bib cock, etc	KINGSTON, KOHLER, Parryware, Jaquware, Hindware or equivalent
75	Textured Plaster	LUXTURE SURFACE COATINGS PVT. LTD, TEXFIN products (NIKO), Everest Industries, Ambience coatings Pvt Ltd or equivalent
76	Stoving Enamel paint, Synthetic & Furniture Enamel paints, Road marking paint, Aluminium Paints, Red	Modi Industries Ltd (paint section), Galaxy paints, TUFF coat Polymers, Nano polycoat, Automark Industries India Pvt. Ltd., or equivalent.

S. No.	Description /Material	Manufacture's Name
	oxide Zinc Chromate Primers, Cement primer, Epoxy paints, Acrylic Distemper, Cement primer, Glowlite putty, varnishes	
77	Wall Putty	J.K White Cement Works, Modi Industries Ltd (paint section), Birla (Adithya Birla Group), Shalimar Paints, Gyproc Wall Putty (Saint Gobain) or equivalent
78	Epoxy paint, Epoxy clear primer, Epoxy Polyurethane floor coating, Epoxy Screed, Epoxy Seal coat, Self-levelling compound (Epoxy, PU, EPU), Patch repair compound, chemical resistant cement mortar, Silicate cements, Resin cement mortars, Epoxy tar compound & Epoxy collar coating	H.C Associates, Arco paints Ltd, Clean coats Pvt. Ltd., Techoxy by Choksey chemicals pvt. Ltd., or equivalent.
79	Cement Tiles, Decorative wall, cladding tiles, Heavy duty tiles, Kerb stone	Hindustan Tiles, Super Tiles & Marble Pvt Ltd, Terra Firma Concrete & Marbles Pvt Ltd., Century Tiles Ltd or equivalent
80	GRC Architectural decorative products like Grass Grid Pavers, drain covers, GRC pavers, GRC tiles, GRC Brackets, GRC decorative columns, GRC planters, GRC noise barriers, GRC Paving Tiles	Terra Firma Concrete & Marbles Pvt Ltd., Unistone cladding and paving, Nimco Prefab, Hindustan Tiles or equivalent
81	High performance coatings, Exterior heat insulation wall paints,	Acro paints Ltd, Berger, Rawlins paints, Thermacote, ESDEE or equivalent

S. No.	Description /Material	Manufacture's Name
	Intumescent fire-retardant paint, Hyenine coating for a clean environment	
82	Construction & water proofing chemicals, Integral Waterproofing compounds, chloride free plasticiser cum waterproofing compound, polymer admixture for waterproofing, flexible polymer modified Cementous waterproofing coating, normal and super plasticizer to reduce water/cement ratio tile adhesive, floor hardeners, Silicon impregnation	Acro paints Ltd, Durobond, Perma Chemicals, Sika, Pidilite, BOSTIK, STP Ltd., Maruti Bitumen Pvt. Ltd., or equivalent.
83	Anti-Corrosive coating for Structural steel, Aluminium, FRP, Wooden, Plastic, Glass surfaces & Concrete.	Grand Polycoats, Berger, ESDEE, Acro paints, Dooal Corpro India Pvt. Ltd., or equivalent
84	Welding Electrodes	ESAB, Advani-oerlikon Weld Alloy, Modi, Arc/Weld excel india, GEE, Honaver
85	Form work Release Agent	FOSROC, MBT, MC Baucheme, Adomast, Conmat
86	SS Railing	The Cavalier; Dune India Pvt Ltd, DORMAT India Pvt Ltd, Sky Port, Q-railing India Pvt. Ltd, Impact metals, Cochin tech, Jindal, Arcat.
87	Ready Mix Concrete	ACC, Unitech, Grasim, L&T, Jindal
88	Expansion Joints	Pre-qualified Manufactures as per RDSO's latest approved list or as approved by KMRL.
89	Pile Integrity& Testing Agency	CBRI, FUGRO-KND, Pile Dynamic, AIMIL, Geo dynamic

S. No.	Description /Material	Manufacture's Name
90	Stainless Steel	Jindal, SAIL, Salem Steel, Hindalco
91	Prestressing Strand (LRPC)	TATA SSL Ltd, USHA Martin, (DP wires, Ramsarup Nirman only if first two supplies are short) or equivalent
92	Pot/Elastomeric Bearing	Pre-qualified Manufactures as per RDSO's latest approved list or as approved by KMRL.
93	Horizontal Tie bars/Shear Bars	BB Bars System, BBV Systems or equivalent
94	HDPE sheathing	Rex Poly extrusion, Gwalior Poly pipes Ltd, Kataria Sheathing, M/s Tirupati, M/s Dynamic Prestress
95	Epoxy	FOSROC, SIKA QUALCRETE, Araldite, BASF or equivalent
96	Prestressing System	Freyssinet, BBR, VSL, Dynamic, Killik Nixon, Tensacciai (India Ltd), JK Prestressing, Usha Martin
97	Hollow sections, pipes	Surya pipes, Hi-Tech Pipes,JSW, JSPL, RINL
98	Drainage pipes	Tirupati plastomeric, Duraline, REX, STIPL or equivalent
99	Acrylic Textured Coatings	Spectrum, Renova, Wallz, Surfa Nova, Jotun
100	Non shrink Grout	Fosroc Chemicals (India), SIKA, BASF, ELCHEM, MBT
101	Bonding Coat	CICO, FOSROC, Sunanda speciality coating Pvt. LTD, BASF, SWC, TAM
102	Steel Structural Fasteners	Pooja Forge, Sundram Fasteners, Unbrako, Nelson, Panchsheel
103	Integral Crystalline Water Proofing Method	Kryton Buildmat Co. pvt. ltd., Penetron, Vandex International Ltd., BASF, Chryso, XYPEX
104	Water stopper/Bar	Kanta Rubber, Greenstreak, Maruti, duron
105	Liquid Polymer membrane water proofing	INTEGRITANK, BASF, MAPEI, PIDILITE, DAVCO, CICO
106	Curing Compound	Clean tech concure, SINAK, FOSROC, Adoadditives, TAM
107	Polycarbonate sheets	M/s Gallina Acroplus, Coxewell, Poly U, Fabric, SABIC, DANAPALON

S. No.	Description /Material	Manufacture's Name
108	Interlock Paving Tiles	Unistone I CCC Builders Merchant Delhi Pvt. Ltd / Nimco Prefab, Hindustan Tiles, Pavertech Constructions Pvt. Ltd., Super Tiles & Marble Pvt Ltd, Terra Firma, Unistone.
109	Fender System	Bridgestone, Trelleborg, Sumitomo, Shibata, IRM, Hi-Tech Elastomers
110	Bollards	Trelleborg, Richard marine, E J Bean, Harbour marine, Marine International IRM, Hi-Tech Elastomers
111	Plywood	Uniply, Europly, Archidply, Century ply, Hunsurply, Duroply (Green marked BWR Grade of Sarda plywood Industries Ltd
112	Block board	Duroboard (Green marked BWR Grade of Sarda plywood Industries Ltd, Century plywood, Green Plywood, Kitply Industries Ltd, Uniply
113	Veneers	Sarda Plywood industries Ltd, Green Plywood, Century Plywood, Kitply Industries Ltd., Greenply
114	Adhesives, Adhesives for tiles and Mosaics, Stone Adhesive, Glass mosaic adhesive	Pidilite, Araldite, Toyo Ferrous Crete (P) Ltd, Apple chemie or equivalent
115	Plastic laminates	Formica, Neoluxe, Bakelite, Hylam, Greenlam Merino
116	Gypsum board for Gypboard dropped ceiling	India Gypsum Limited, Gyproc (Saint Gobain), Lafarge Boral Gypsum India Pvt Ltd. or equivalent
117	Calcium silicate board	Promate, Hilux, Aconpan, Aerolite. or equivalent
118	Aluminium Structural Members	Hindalco Industries Ltd, Jindal Aluminium Ltd, Indalco Alloys or equivalent
119	Aluminium Linear Ceiling	Luxalan, Interarch, Armstrong, J C Industries, Hunter Douglas or equivalent
120	Aluminium Louvers	Hunter Douglas-LUXALON H-3, CS-RS-1605, Euro Build or equivalent
121	Steel Panel Ceilings	Interarch, Armstrong, Metckaft or equivalent
122	Mineral fiber ceiling	Armstrong, Anutone, Amazone, Kingston or equivalent
123	Grid Ceiling	Armstrong, anutone, luxalon, Everest, Aerocon, RAMCO Hilux or equivalent

S. No.	Description /Material	Manufacture's Name
124	Perforated/Non perforated Metal Ceiling	Hunter Duglus India Pvt.Ltd, Saint Gobain Gyproc India Ltd, Anutone, Armstrong, Fameline
125	Baffle Ceiling	Armstrong, Hunter Douglas, Hypersil or equivalent
126	Honeycomb panel	Durabuild, Alcomex (Dongshine), Alucobond, Hunter Douglas or equivalent
127	PUF Panel	Jindal Mectec, Alfaa, TATA, Uma puf panel, Epack polymers Pvt Ltd or equivalent
128	Resin Bonded Glass Wool	Rockloyd, Kingsway, LLYOD Insulations (INDIA) Ltd or equivalent
129	Bevelled and Embossed Glass/Mirrors	Gujarat Guardian Ltd, Modi, Saint Gobain or equivalent
130	Aluminum Sections	Indian Aluminium Co. Hindustan Aluminium Jindal, Bharuka, Bharat Aluminium Company Ltd, Vedanta, Alco, Hindalco.
131	Float Glass/Toughened Glass/Insulating Glass/Laminated Glass	Float Glass India Ltd, Asah Float, Modiguard Reliable Ltd, Glaverbel, Saint Gobain, Tata Float
132	Powder coatings	Berger, Nerocoat, Jenson & Nicholson, Radiant, Anodisers Pvt Ltd.
133	Asphalt Emulsion	Karnak Chemical Corporation, STP, Repsol, CECA chemicals or equivalent
134	Alco panel Cladding	Lennox, Alcotex, Durabuild, Viva or equivalent
135	Curtain Wall Glazing	Saint Gobain, Europa, laminex, European Façade Products or equivalent
136	Exterior cladding	Hunter Douglas, Fundermax or equivalent
137	Sanitary Fixtures	Duravit, Kohler, Queo, Artize, Hindware
138	Plumbing Fittings	Kohler, Jaquar, Artize, Toto, Grohe
139	Concealed flush	Geberit, Grohe, Artize, Jaquar, Kohler
140	Toilet accessories	Bobrick, Euronics, Simex, Jaquar, Hindware
141	Fixtures for specially abled	Hindware, Toto, Cera, Roca, Jaguar

S. No.	Description /Material	Manufacture's Name
142	Water Heater	Racold, V-Guard, Jaquar, Kenstar, Crompton
143	Polyethylene water storage tank	Hycount, Sintex Aqua Tech or equivalent
144	Stainless Steel Sink & fittings	Diamond, Cera, Neelkanth, Nirali, Shri Navkar metals limited or equivalent
145	Manhole cover	Jayswal Neco Industries, INFRA, Trustman, KCE, Kamala, Thermodrain (F.R.P Cover) or equivalent
146	Hose Pipe (Synthetic)	Jayasree, New Age, CRC, Rosen Bauer or equivalent
147	CS PIPES	Tata, Jindal, Sail, Amardeep Steel, Ganpat Industrial Corporation or equivalent
148	SS PIPE	Chokshi, Swastik, Apex, Chandran Steel, Jindal or equivalent
149	HDPE Pipe & specials	Utkarsh India Limited, Jain Irrigation, Duraline India, Supreme Industries, Kriti Industries Limited, Sangir Plastic
150	Compact Laminate, Toilet Cubicle And Modesty	Greenply Industries Limited, Merino Industries Ltd, Macro Enterprises or equivalent
151	Fire Extinguisher	New Age, Minimax, Nitin, Fire traces, TYCO, Safex or equivalent
152	High tensile Bolts /Screws	HILTI, Fischer, Unbrako, TVS, Euro Build
153	Geotextile	Techfab, Suntech, Terrum, Manas, Mono industries,
<p>Note: The list of vendor/make is furnished here with shall be used in the works. The contractor shall have to obtain prior approval from the Employer for the list of items those are not indicated/specified in the list for use in the works.</p>		

B1700 RECLAMATION WORKS

B1701 DESIGN OF RECLAMATION WORKS

B1701.1 Scope

B1701.1.1 The scope of works includes but is not limited to the design, supply, installation, construction, monitoring, testing and quality assurance, commissioning and maintenance of the following,

- (i) Reclamation works
- (ii) Instrumentation and monitoring systems

B1701.1.2 The permanent limits and finished surface elevations at completion of Works and handover of areas of reclamation required are shown in the Drawings.

B1702 PURPOSE OF RECLAMATION

B1702.1 The purpose of reclamation is to provide sufficient land area and a stable platform required as part of the Works.

B1703 SEQUENCE OF WORK

B1703.1 The contractor is free to adopt any appropriate sequence of work so as to meet the time lines and satisfy Employer's Requirements. The sequence of reclamation and ground improvement, if any shall be submitted by contractor to Employer for approval at least 28 days prior to the intended date for first commencement of the construction Works.

B1703.2 The contractor can change the work sequence as per the site condition with prior notification to the Employer. If any dispute arises, then the decision of Employer will be considered as final and shall be acceptable to the contractor without any additional cost.

B1704 DESIGN OF RECLAMATION

B1704.1 Areas of reclamation shall be designed and constructed to accommodate the design loadings, and such loads as stated in the Specification, without significant ongoing settlements which may damage or affect the efficiency of operation throughout its design life.

B1704.2 Reclaimed filled areas shall be treated, where required, to provide adequate stability and bearing capacity to withstand the applied loadings and to meet the settlement and other criteria defined in these specifications and to provide a firm foundation for construction of various structures as shown in the drawings.

B1705 LOADING

B1705.1 The reclamation including ground shall be capable of supporting construction traffic, construction operations and loads arising from the permanent works under all operating conditions. The Contractor shall calculate the design load with considering all possible loading conditions and use it for the design.

B1705.2 Minimum design load on the reclamation area as given below:

Description	Minimum Load for design
Reclamation Area with Roads	25 kPa
Loading on vertical retaining wall	50 kPa
Backup yard	30 kPa

B1705.3 Temporary and Permanent Bund Design

B1705.3.1 The Contractor shall design, construct and maintain perimeter, internal, intermediate bunds to the desired crest-heights with adequate freeboard prior to reclamation in order to allow i) safe placement of the spoil and ii) settling of the fill material in an orderly fashion and allowing for drainage of the tailwaters with water levels which are conducive to produce maximum settlement capacities in the ponds.

B1705.4 Selection of Material for Reclamation

B1705.4.1 Borrowed material shall be considered as reclamation fill which comprises of graded sands and gravels, gravel-sand/ silty-sand mixtures, crushed graded rock; (GW, SW, GP, SP, etc.). The material shall be free from any debris, waste, organic material, and other deleterious materials.

B1705.4.2 Suitable fill material shall be accessed by the contractor from the specified quarry sites, selected from stockpiles. The grading of borrowed material shall be selected in such a way that it will meet the requirements set in the design. The selected material used in reclamation shall meet the following minimum requirements:

- (i) The material shall be free from organic matter,
- (ii) Maximum particle size : 100mm
- (iii) Plasticity Index: <15%

B1705.4.3 The identification, selection, assessment of suitability, demonstrating that those materials will satisfy the Employer's Requirements and volume availability of the reclamation materials is the sole responsibility of the Contractor.

B1705.4.4 The Contractor is solely responsible for gaining all permits for the extraction of the material, transport and all aspects of its use, including obtaining any necessary environmental permits.

B1705.4.5 All such material shall be consistent with the design requirements which shall be outlined in the Contractor's Design Documents. For each material used in the reclamation, the Contractor's Design Documents shall define the required parameters for the materials necessary for the successful implementation of the design, including but not limited to:

- Grading
- Percentage of fines
- Aggregate impact value
- Magnesium sulphate soundness
- Shear strength
- Compaction
- Density
- Water absorption
- Soaked CBR
- Plasticity Index, Plastic Limit, Liquid Limit
- Organic Content

- B1705.4.6 After selection of material source, Contractor shall transport the material to the designated stockpile area and submit a material testing report which comprises of above mentioned tests to the Employer for approval. Suitable and unsuitable material shall be identified at stock pile site and only selected suitable material shall be used for reclamation fill.
- B1705.4.7 The fill shall also be tested to determine the compaction characteristic in accordance with IS 2720.
- B1705.4.8 Material obtained from the borrow site may be used as reclamation fill, subject to the Contractor's design verifying that the Design Criteria requirements will be met. The Employer does not give any warranty, representation, assurance, promise as to the quantity, quality, location, availability to suit the Contractor's programme and/or fitness for purpose of the fill which may be obtained from the dredging. The Contractor shall be solely responsible and ensure that the reuse of dredged material in the reclamation shall comply with the requirements of the Employer's Requirements and the Design Criteria.
- B1705.4.9 The minimum specification of material quality stated above shall apply to all material (as applicable) used in the construction of the reclamation and revetment/sea wall. The Contractor shall determine, identify and prepare the proposed material testing plan which shall identify which tests shall be carried out on each material proposed.
- B1705.4.10 Where clay/silt is present, it shall be improved to meet the Design Criteria as appropriate.
- B1705.4.11 The grading and compaction of the fill shall be such that it will not be subject to liquefaction under the seismic loads defined in the Design Criteria.
- B1705.4.12 Material used in temporary reclamation bunds (in case the same is adopted) shall be adequate to provide a stable core and shall be capable of resisting pressures / forces arising from the placement of fill and ground improvement operations, if any.
- B1705.4.13 The Contractor shall be responsible for the reinstatement of any fill or surcharge materials washed away by tidal or weather conditions.

B1705.4.14 All reclamation material shall be in accordance with the Contractor's Documents and design requirements. Material shall only be used in the works after review by the Employer and after the material is tested and shown to be in accordance with the design requirements.

B1705.5 Stability analysis of Edge Structure

B1705.5.1 Slope stability analyses of the edge structures (sheet pile wall) shall be carried out to examine all possibilities including circular and non-circular failures using methods of analysis in accordance with the recommendations of BS 6031. The effects of earthquake loads shall be considered including the potential for liquefaction and softening.

B1705.5.2 In the absence of Indian Standard codified requirements for the design of embankments for seismic events, the Employer accepts the use of "IITK-GSDMA Guidelines for Seismic Design of Earth Dams and Embankments (2007)".

B1705.5.3 In adopting these guidelines, the Contractor shall adopt an Importance Factor (I) of 1.5.

B1705.5.4 The Contractor shall adopt a FoS as given in these specifications. The use of partial material factors is not accepted.

B1705.5.5 The design FoS of the reclamation stability due to seismic events in the temporary stages (i.e. construction) shall be the responsibility of the Contractor. Any damage from slips occurring at this stage shall be repaired by the Contractor at no cost to the Employer.

B1705.6 Slips and Bund Failures

B1705.6.1 It is the requirement of the Contract that no bund failures (in case if temporary bund is proposed) are to occur and bund designs and bund materials should be selected to facilitate this requirement.

B1705.6.2 If any part of the bunds, berms, reclamation edge structures, sheet pile walls or reclamation become unstable or a slip appears to be imminent by measurement, testing or observation the Contractor shall divert operations to other areas and shall be responsible for any rectification or delays. Any costs for rectification or delays due to slips shall be to the Contractor's account.

B1705.7 Settlement Assessment

B1705.7.1 Settlement analysis shall be undertaken to evaluate the elastic short term and long-term settlements due to the Design Load.

- B1705.7.2 Wherever the improvement of clayey soils are necessary, in addition to achieving the required settlement limits, the settlement analysis shall demonstrate that at least 95% of the primary consolidation is complete before any ground treatment, if any is removed or is considered complete. In no case shall the ground treatment surcharge load be less than the Design Load. The amount of residual settlement shall be determined with appropriate software and shall include the calculation of creep as well as secondary compression and primary consolidation.
- B1705.7.3 The Contractor shall submit calculations of the settlement effects of earthquake loading as well as calculations of the settlement effects due to static load effects.
- B1705.7.4 As part of the Contractor's design, the selection of reclamation material, placement, ground improvement design and sequencing shall be undertaken. The Contractor shall be responsible for determining and addressing the issue of liquefaction.
- B1705.8 **Liquefaction Potential**
- B1705.8.1 The liquefaction potential of the combined reclamation fill and underlying soil shall be ascertained in accordance with IITK-GSDMA Guidelines for Seismic Design of Earth Dams and Embankments, with reference to Appendix A Section 2 of IITK-GSDMA Guidelines for Seismic Design of Earth Dams and Embankments, the fill is not susceptible to liquefaction. Earthquake related permanent ground deformation is considered to be negligible, if FOS against liquefaction is larger than 1.1.
- B1705.9 **Compaction of Reclamation Fill**
- B1705.9.1 Ground improvement measures shall be required for the recently placed reclamation fill to meet the performance requirements.
- B1705.9.2 The Contractor shall carry out ground Improvement of recently placed fill, comprising the supply of equipment, labour and materials to achieve compaction of the full depth of soil strata such that the soil is compacted to a required density.
- B1705.9.3 All the ground Improvement parameters adopted during the field trial test shall be duly recorded. These include but not limited to the drop height, pounder weight and dimension, spacing and grid of the compaction points, no. of drops per compaction point, crater dimensions and average enforced settlement.
- B1705.9.4 In the case of high impact rolling, the weight and dimensions of the rollers, the speed of travel, the number of passes, and any other relevant parameters that are recorded by the rollers.

- B1705.9.5 Improvement shall be carried out by repeated tamping on the proposed pattern with drop heights appropriately chosen to ensure compaction to the full design depth. In addition, there shall be an adequate margin of Improvement outside the periphery of the Improvement area to ensure long term stability of Improvement area. If a change in pattern of tamping, drop heights or total amount of energy is required it shall be carried out without delay and, unless resulting from unforeseen conditions, without cost to the Employer.
- B1705.9.6 All the fill material placed as a reclamation fill up to the finished ground levels, shall be compacted to a minimum 95% relative compaction by means of dynamic compactor or vibratory roller compaction as per the design. The Proctor optimum moisture and maximum dry density shall be determined, in accordance with IS 2720 (part-8) - 1980, Compaction Test (4.9 kg rammer method). The acceptance by the Employer of such test results shall not relieve the Contractor of the responsibility that the fill material in the reclamation area shall comply with the Specification.
- B1705.10 **Ground Improvement**
- B1705.10.1 Reclaimed fill areas and soils below bunds shall be treated by adequate ground improvement methods, as necessary, to provide adequate stability and bearing capacity to withstand the applied loadings defined in the Specifications and to provide a firm foundation for construction of structures and to achieve the specified settlement criteria.
- B1705.10.2 The scope of the ground improvement works includes but is not limited to the following major work elements:
- (i) Carry out detailed design of the ground improvement works and prepare detailed design reports.
 - (ii) Excavation and replacement of the unsuitable soils, where required.
 - (iii) Demonstration of the effectiveness of the ground improvement works in accordance with the design carried out by the contractor or subject to the Employer's instructions otherwise stated.
- B1705.10.3 Ground improvements may be required to be undertaken by the Contractor considering a range of techniques, including but not limited to any individual or combination of the following:
- (i) Surcharge
 - (ii) Band Drains with surcharge
 - (iii) Deep cement stabilisation
 - (iv) Sand Columns
 - (v) Stone Columns
 - (vi) Lime stabilisation
 - (vii) Vibro compaction
 - (viii) Dynamic compaction
 - (ix) Other

B1705.10.4 The choice of ground improvement technique shall be the Contractor's selection to suit its design, ensuring at all times that the requirements defined in the Employer's Requirements and the Design Criteria are achieved.

B1705.10.5 Detailed testing and stability analyses shall be undertaken to demonstrate the stability of all perimeter bunds both during and after construction of all stages of the Works.

B1706 RECLAMATION AND EDGE STRUCTURE PERFORMANCE

B1706.1 Areas of reclamation shall be designed and constructed by the CONTRACTOR to accommodate the specified minimum applied loads. The reclamation areas, which may be treated by adequate ground improvement methods, if necessary, shall be designed to withstand the operational loads and to comply with the following criteria:

B1706.2 Analysis of slopes

B1706.3 Overall Slope Stability of reclamation slopes, Vertical pile walls:

Factor of Safety > 1.2 Temporary Condition (Static)

Factor of Safety > 1.3 Normal Condition (Static)

Factor of Safety > 1.0 Contingency Level Earthquake (CLE)

Factor of Safety > 1.1 Operating Level Earthquake (OLE)

B1706.4 **Settlement Limits**

(i) Total settlement of less than 100mm over 50 years for a uniform loading of 30kN/m² applied at the surface of the required reclamation level over the entire reclaimed area including for internal settlement of the reclaimed material under self-weight.

(ii) Angular distortion (differential settlement) to be less than 1 in 200 over a 10m length (50mm in 10m).

(iii) The Contractor shall also demonstrate that his proposed ground improvement method, with his detailed calculations, will achieve a total residual settlement, after completion that shall not exceed 10% of the estimated total ground settlement.

B1706.5 **Compaction**

B1706.5.1 Reclamation fill material placed below water table shall be compacted by means of suitable method to achieve Relative Compaction of fill > 90%.

B1706.5.2 The uppermost zone of fill shall be placed and treated to ensure that the top of the fill material above water table has an in-situ density not less than 95% of the maximum dry density.

B1707 CONSTRUCTION WORKS FOR RECLAMATION

B1707.1 Sequence of Work

B1707.1.1 The sequence of reclamation and ground improvement shall be submitted by contractor to Employer for approval at least 28 days prior to the intended date for first commencement of the construction Works. The permanent limits and finished surface elevations at completion of Works of reclamation required are shown in the Drawings.

B1707.2 Cleaning and Grubbing

B1707.2.1 Clearing and grubbing land including removal of stumps of any size and roots of trees of any girth, mangrove of any size, left over after cutting of trees of all girths, excavating up to average 300mm thick to carry out the operations etc. complete as per technical specifications and as directed by Employer.

B1707.2.2 The Contractor shall give the Employer twenty one (21) days' notice of his intention to demolish or dismantle all or any existing structures on the Site which in the Contractor's opinion is necessary for the completion of the Works.

B1707.2.3 Burning operations, if approved by the Employer, shall take place at locations to be indicated by the Employer's Representative under the constant care of a competent watchman at times that burning is taking place. Fire extinguishing equipment will be in place and immediately available for use.

B1707.2.4 The Contractor shall at all times and in all respects take the necessary actions to protect the environment in and around the Site by adhering to the measures detailed in his Environmental Management Plan. The Contractor shall do the utmost to spare trees, vegetation, flora and the like. If the Employer's Representative requires that individual trees, shrubs and hedges are to be preserved the Contractor shall do so and shall take all necessary precautions to prevent their damage.

B1707.2.5 The disposal of the excavated material shall be carried out as directed by Employer.

B1707.2.6 The temporary storage of excavated material in the reclamation areas for re-handling shall be permitted with the approval of the Employer. Full details, including estimated quantities, shall be provided in the Work Method Statements indicating detail plan.

B1707.3 Placement of Reclamation Fill

B1707.3.1 Fill material shall be deposited in a manner and sequence such that minimum lateral displacement of the underlying material will be induced and such that slopes are stable at all times.

B1707.3.2 Where material is placed mechanically the method of deposition shall ensure that the resulting distribution of material does not permit segregation of material. Where necessary additional sampling and testing of the material shall be carried out in order to demonstrate that all material placed is in accordance with the specified requirements.

- B1707.3.3 The deposition of fill shall be by methods which do not promote segregation or layering of the fill material. The manner and sequence of deposition of fill shall be such that displacement of in-situ material and displacement or migration of deposited materials is to be avoided.
- B1707.3.4 The rate of filling in the vicinity of erosion or pressure sensitive areas shall be kept within safe limits and be adjusted so as to avoid any excessive buildup of pore pressure in the underlying materials so as to prevent bund failure.
- B1707.3.5 As per the design, granular filter material/geotextile filter or a combination of both shall be placed in such a manner that a continuous free draining zone is formed at the interface of bund/sheet pile wall and reclamation area.
- B1707.3.6 The Contractor shall not fill areas outside the limits or the prescribed boundaries.
- B1707.3.7 At least 30 days prior to the proposed commencement of any filling works on Site the Contractor shall submit a method statement for the Employer's consent.
- B1707.4 **Fill of Tolerances**
- B1707.4.1 The area to be reclaimed up to the finished level and the permitted tolerances are given hereafter.
- B1707.5 **Vertical Tolerance:**
- B1707.5.1 The maximum deviation from the design fill level is ± 0.20 m at any point. The average tolerance limit for an area of 10,000 sqm shall be 0.05 m.
- B1707.6 **Horizontal Tolerance:**
- B1707.6.1 The edge of the reclamation at the finished level shall not vary in plan from the line shown on the approved design drawing by more than ± 1.0 m at any point. The average deviation over any length of 100 m shall not exceed ± 0.50 m.
- B1707.7 **Ponding of Water**
- B1707.7.1 No ponding of water behind the advancing reclamation will be allowed. The Contractor shall advance the reclamation on sufficient dispersal lines to avoid ponding or accumulation of water. If the Works are delayed due to inadequate draining of the reclamation or settlement areas all delay costs shall be to the Contractor's account
- B1707.8 **Peripheral Bund & Internal Bunds**
- B1707.8.1 Prior to the commencement of reclamation, the Contractor shall construct a suitable temporary internal bunds and/or permanent edge structure, which has to be vertical face, as necessary for the reclamation works.

B1707.8.2 The retaining structures will meet the performance criteria set out in these Specifications and meet with all relevant safety and design standards. In addition, a drainage path, collection system and discharge system shall be included to collect seepage through the bunds, if any, before any waters cause flooding in surrounding areas.

B1707.8.3 Prior to placing of borrowed material to reclamation area the contractor shall install internal bunds to subdivide the areas bounded by the peripheral bunds for the holding and settling of solids as required by the contractor's work method.

B1707.9 Maintenance and protection of Retaining Structures

B1707.9.1 The Contractor shall maintain and protect the internal and external surfaces of all retaining structures from weather, sea conditions, current, cyclone conditions, hydraulic erosion from the reclamation operations and reinforce the rear and fronts of the structures with additional material where required.

B1708 GEOTEXTILE MATERIAL

B1708.1 All geotextiles shall be manufactured by and purchased/obtained from a reputable manufacturer(s) and ISO 9001: Compliant. The manufacturer(s) shall have ample experience in the fabrication of the type of geotextile specified.

B1708.2 Before ordering any quantity of geotextile, the Contractor shall submit samples, and test reports from an approved independent testing laboratory accredited in accordance to ISO 17025 and certified by GAI-LAP certification. The test reports from laboratories without accreditation are not acceptable.

B1708.3 The Geotextile is supplied in Roll. Each Roll shall be wrapped using good quality wrapper. A packing label is pasted on the roll and also at the inner face of the core of the roll.

B1708.4 The packing label shall necessarily indicate:

- (a) Manufacturer's name,
- (b) Type of geotextile (Product code and Product grade)
- (c) Manufacturing date.
- (d) Roll No. & Lot no.

B1708.4.1 No geotextiles shall be used in the Works which were manufactured more than one year prior to arrival on Site.

B1708.4.2 The geotextile shall not be exposed more than 6 weeks to Sun-light. In case of higher exposures are needed, it should be covered temporarily with a 90gsm tarpaulin cloth till it is permanently covered.

B1708.4.3 The contractor shall design the geotextile properties required for this project and submit to Employer for approval.

B1708.5 Laying of geotextile

- B1708.5.1 The surface on which geotextiles are placed shall be relatively smooth, free of obstructions, depressions and soft pockets. Depressions shall be filled with compacted material as directed by the Employer. Placing of the geotextile shall not start until underlying slope has been approved by the Employer.
- B1708.5.2 The geotextile shall be placed loosely without wrinkles or folds with the warp running normal to the coastline. The geotextile will be laid in one piece over the required depth. Lapped joints will not be permitted. Joining of geotextile strips shall be achieved by stitching.
- B1708.5.3 No joints in the geotextile are allowed perpendicular to the coast. All seams (if used) must face upwards from the sea bottom to allow for inspection and repair. A surplus of minimum 10 mm of geotextile shall be provided at the seams to allow movement.
- B1708.5.4 Holding the geotextile in position shall be by ballasting with the filter rock. Pinning with steel pins or wooden pegs will not be allowed. No cover layer shall be placed on top of the geotextile without approval by the Employer.
- B1708.5.5 From the time the textile is removed from storage for incorporation into the works, until it is placed and covered by the first gravel layer shown on the drawing, the total period shall not exceed 7 days. No geotextiles shall be placed in the Works which cannot be covered with protective elements the same day.

B1708.6 Ground Improvement

- B1708.6.1 The Contractor shall undertake all design, construction and ground improvement performance verification as necessary to the satisfaction of the Employer to ensure that the ground improvement works satisfy the performance requirements stipulated in the Employer's Requirements.
- B1708.6.2 Engineering requirements to be addressed by the Contractor in his selection of the most appropriate methods of and equipment for any ground improvement to be undertaken at the Site, in order to meet the Employer's Requirements, shall include but shall not be limited to the need to control lateral earth and water pressures on the seawall, under normal condition.
- B1708.6.3 Where the adoption of more than one form of ground improvement has been approved by the Employer, the areas within which each form of ground improvement are to be used shall be carefully delineated by the Contractor having due regard to the soil conditions to be expected in each part of the Site.

B1708.7 Method of Improvement

- B1708.7.1 Ground improvement shall be carried out for Reclaimed fill up to the depth of recent fill (existing seabed to ground level) and also in the soils below Reclamation fill & Bund (if any) as per the design and drawings approved by the Employer.

- B1708.7.2 The choice of a particular method of ground improvement shall be decided by considering the degree of improvement required, the depth of fill to be treated, the proximity to existing structures or facilities, and the relative cost benefits.
- B1708.7.3 The fill material placed at top two meter of reclamation area up to make up ground levels, shall be compacted to achieve maximum dry density of 95% by means of mechanical vibratory roller or tendon roller. The required number of passes roller weight, roller speed, frequency, amplitude of vibration shall be decided based on the trial compaction and to meet the required MDD as per this specification. If the required compaction is not achieved with the above mentioned number of passes then number of passes shall be increased till the final compaction is achieved. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.
- B1708.7.4 The fill material place in underwater and above water shall be compacted by means of dynamic compaction or roller compaction or any other method as per the design approved by the Employer.
- B1708.7.5 The soft soil below the Reclamation Ground shall be treated using any of the ground improvement technique to achieve the Relative Density of minimum 70% ,as necessary, to provide adequate stability and bearing capacity to withstand the applied loadings defined in the Specifications and to provide a firm foundation for construction of costal road structures and to achieve the specified settlement criteria.
- B1708.7.6 Acceptable methods of in situ soil improvement works are likely to include:
- (a) Replacement of unsuitable soft soils
 - (b) Adequate methods of improvement to ensure compliance, including but not limited to preloading, wick drains, dynamic compaction, vibro-compaction, sand compaction piles, stone columns and deep cement mixing etc.
- B1708.7.7 The contractor is required to plan and perform the ground improvement under water as well as on the land side.
- B1708.7.8 The Contractor shall submit the construction sequence and methodology for ground improvement works to the Employer a minimum of two weeks before the commencement of the works.
- B1708.7.9 The scope of the ground improvement works includes, but is not limited to, the following major work elements:
- (a) Seek the Employer's approval to undertake the ground improvement works as designed and proposed
 - (b) Install monitoring instrumentation such as surface settlement markers, multi-level pyrometers, standpipes and observation wells, inclinometers, and other suitable instruments. The contractor shall submit the instrumentation plan and schedule to Employer for approval prior to start of work.
 - (c) Closely monitor the behaviour of the reclamation areas during the ground improvement phase.

- (d) Submit regular instrumentation monitoring reports to Employer.
- (e) Carry out quality control field tests on ground improvement elements during and after installation.
- (f) Carry out pre and post-ground investigations to confirm that the ground has been improved to the required relative density of minimum 70% or 95% MDD.
- (g) Prepare pre-ground improvement, and post-ground improvement assessment report to confirm that the design objectives have been met, for the review of the Employer. Demonstration of the effectiveness of the ground improvement works in accordance with the test procedures set out hereunder or subject to the Employer's instructions otherwise stated. The acceptance by the Employer of such test results shall not relieve the Contractor of the responsibility that the fill material in the reclamation area shall comply with the Specification.
- (h) Details of sequencing of filling with construction of the perimeter and internal dividing bunds, so that stability of the bunds is maintained.
- (i) Methods for working within bund areas to achieve the required soil Specifications and levels.
- (j) Ground settlement after improvement shall be brought to final finish level and compacted using vibratory roller to meet the minimum required density criteria as specified in these specifications.

B1708.8 Performance Criteria

- B1708.8.1 The Contractor shall be responsible for the construction, performance verification (including pre and post treatment testing, instrumentation and monitoring) and rectification of any defects in and upon completion, of any and all of the ground improvement works adopted for the development.
- B1708.8.2 The Contractor shall provide such technical expertise, plant, materials, standards, workmanship etc. that may be necessary or desirable to meet the performance requirements as specified in the specifications.
- B1708.8.3 Following completion of the cutting and filling of the ground surface, after to the commencement of compaction, the Contractor shall undertake CBR testing at the final grade level to ensure that the material can satisfy the relevant design CBR requirements specified by Employer.
- B1708.8.4 The field CBR testing shall be carried out in accordance with IS: 2720 Part 16 on the compacted in-situ soil to the same relative density specified above. The Contractor shall submit the test results to the Employer for approval prior to the commencement of any subsequent compaction or filling activities.

B1708.9 Compaction Acceptance Criteria

B1708.9.1 The degree of compaction shall be sufficient to achieve a dry density of not less than 95% of proctor's dry density at optimum moisture content as per IS-2720 (Part – VIII) as per IS-2720 (Part-XIV) as applicable depending on the nature of filling material. The work of filling will be accepted after the Employer is satisfied with the degree of compaction achieved.

B1708.9.2 The quality testing shall be done and comply with table below.

Test	Frequency
Field density test by sand replacement method	<ul style="list-style-type: none"> • 1 test for every 1000 Sq.m. of each compacted area. • In areas where the degree of compaction is doubtful
Field CBR test	<ul style="list-style-type: none"> • 1 test for every 3000 cum. on the top 500 mm of the compacted layer • The bulk sample shall be collected preferably from the road area.

B1708.10 Acceptance of Settlement Criteria

B1708.10.1 The Contractor shall be responsible for reviewing the instrumentation monitoring data, estimating the long-term residual settlements based on the monitoring data, preparation of settlement report, and ensuring that the settlement criteria as given in the Employer's Requirements are achieved.

B1708.10.2 In case failed in achieving the Employer's Requirements, the Contractor shall investigate the cause of the non-achievement and propose remedial measures with detailed calculations to the Employer and re-improve the ground without any additional cost. The Contractor's proposed remedial measures shall not in any way delay the prescribed dates for handover of the Site and affect the stability and structural integrity of all features including but not limited to seawall, reclamation edge slopes and utilities and the existing buildings and other features under any other proposed remedial measures.

B1708.11 Acceptance of Ground Improvement

B1708.11.1 The uppermost zone of fill shall be placed and treated to ensure that the top 2m of the fill has an in-situ density not less than 95% of the maximum dry density. The in-situ density of fill throughout the full thickness and lateral extent shall not be less than 90% of the maximum dry density. The values of maximum dry density shall be obtained in accordance with BS 1377: Pt. 4: 1990.

B1708.11.2 The soft in-situ soil below reclamation fill, bunds and seawall (if any) after ground improvement shall be tested by undertaking cone penetration test (CPT) at least full depth of soft zone, to demonstrate compliance with both the Employer's requirements and contractor's design requirements. Where CPT (SCPT/DCPT) cannot be carried out due to obstructions, SPTs shall be carried out within drill holes at every 1.5m interval till the final improvement level reached.

B1708.12 Field Trails and Monitoring

B1708.12.1 Prior to ground improvement works adopted the Contractor shall carry out trials to demonstrate the adequacy of the proposed improvement methods to achieve the requirements of the Contractor's design, and to examine the sequence of operations.

B1708.12.2 The trials shall take place at a location as specified in the Contractor's approved drawing with adequate monitoring instrumentation and pre and post treatment testing as agreed by the Employer. The results obtained from the trials shall be used to assess the acceptability of the initial design.

B1708.12.3 The Contractor shall submit detailed report of trail tests for approval of Employer. In case, based on the field trials, if any variation in the Ground Improvement design is required to meet the specification requirements, then the Contractor shall suggest the revised ground improvement design to meet the requirement of the specifications. The Contractor shall not claim any additional cost by any means of any change in the design.

B1708.13 Instrumentation and Monitoring

B1708.13.1 The Contractor shall design, install and operate a regime including instrumentation, to monitor geotechnical parameters in the reclamation and underlying soils at all times during the construction of the Works. Such a regime shall be agreed with the Employer. The monitoring shall begin at the commencement of the reclamation and continue during and post ground improvement up to the issue of the Taking Over Certificate for each Section of the Works or until such time to be agreed with the Employer.

B1708.13.2 The Contractor shall submit the proposed method for carrying out monitoring surveys, including the proposed positions of all monitoring points, for review by the Employer. The method and programme of work shall allow for working around future construction by others.

B1708.13.3 Settlement performance requirements given in the Design Criteria shall be assessed against levels recorded at the time of taking over of the individual areas.

B1708.13.4 The Contractor shall record the specific location into which the fill material from each sample is deposited.

- B1708.13.5 The Contractor shall also record the results of all compaction and in situ density tests and shall identify these results with the various locations and elevations at which fill material has been placed and the location from which fill material was obtained.
- B1708.13.6 The minimum monitoring for the reclamation and ground treatments works shall include, but not be limited to:
- (a) Weekly level surveys of any surcharge or reclamation levels, to assess any settlement and movement of the reclamation
 - (b) CPT and SPT testing at every 1000m² area
 - (c) Settlement plates, installed both at depth and at the surface on 25m x 25m grid
 - (d) Instrumentation clusters, installed at the rate of at least one cluster per 5,000m² of ground improvement. The clusters shall be on an alternative grid to the settlement plates. Clusters shall include rod and/or magnetic extensometers, inclinometers, water stand pipes, pneumatic and/or hydraulic piezometers as appropriate to meet the requirements.
 - (e) Plate load tests
- B1708.13.7 The monitoring regime shall provide sufficient information to:
- (a) Determine the effect on reclamation stability of the rate of filling and internal water pressures.
 - (b) Assess the stability of the overall reclamation fill
 - (c) Determine reclamation final surface levels
 - (d) Determine settlement rates
 - (e) Provide detailed information on the performance of the reclamation fill and ground improvement to allow the Contractor to validate the design assumptions and predict the long-term settlement behaviour of the ground improvement and reclamation fill.
 - (f) Establish whether or not the reclamation and ground improvement works are functioning in accordance with the design.
 - (g) Refine the design of ground improvement works for subsequent sections of the reclamation
 - (h) Verification of settlement predictions
- B1708.13.8 The location and arrangement of all instrumentation and monitoring shall be submitted to the Employer for review in accordance with the procedures outlined in the Employer's Requirements.
- B1708.13.9 The Employer shall be notified a minimum of 24 hours, before the installation of each geotechnical instrumentation starts.
- B1708.13.10 All instrumentation shall be monitored at least twice a week during the period of surcharge or ground treatment for a period of 6 months
- B1708.13.11 Should any of the instrumentation be damaged or become non-functional for any reason, the Contractor shall immediately replace the equipment and restore it to full working order.

B1708.13.12 The Contractor shall submit a report to the Employer on the instrumentation every week. The report shall include, but not be limited to, the following:

- (a) A plan showing instrumentation locations
- (b) Provision of all raw data
- (c) Graphs and Plots for each instrument showing settlements and excess pore water pressures (as appropriate) relative to time and reclamation fill thickness.

B1708.14 AAA Monitoring System

B1708.14.1 Any existing and newly constructed structures or utilities within or adjacent to the site, which may be subjected to undue movement and/or settlement by the adjacent Contractor's construction activities, including but not limited to excavation, ground improvement, and temporary works, shall be monitored regularly during the construction activities.

B1708.14.2 Movement control levels for the monitored elements shall be defined in accordance with the following criteria.

- (a) Alert Level - Remedial measures agreed.
- (b) Action Level - Remedial measures instituted and revised Alert and Action levels set.
- (c) Alarm Level - Serviceability limit, stop work.

B1708.14.3 Alarm level value is defined as the highest or lowest (as appropriate) reading anticipated based on the design. In no case the readings are not to be exceeded beyond this level during the work.

B1708.14.4 Action level value will be established as approximately 90% of the Design Values. Allowable level reading is considered to be failing to comply with the maximum or minimum (as appropriate) levels consistent with the requirements of the contract.

B1708.14.5 Alert level will be established as approximately 70% of the Design values. Remedial measures become effective when alert values are exceeded.

B1708.15 Failure to Comply

B1708.15.1 Where an area(s) of ground subject to ground improvement verification has (have) failed to comply with the performance requirements of the Specification, the area(s) of non-compliance shall be re-treated by means of the final approved method of ground treatment so that compliance with the Specification is achieved to the satisfaction of the Employer. The Contractor shall promptly submit alternative ground improvement proposals to be undertaken at a nearby area for the Employer's consideration. Such alternative ground improvement proposals shall not differ significantly from those already approved and subjected to verification without good reason and all changes shall be discussed in detail with the Employer and his approval sought to their implementation.

- B1708.15.2 Following approval of the Contractor's revised proposals for ground improvement, ground improvement of the newly designated area shall be completed to the satisfaction of the Employer incorporating such amendments in methodology as agreed. The new area of ground improvement shall then be subject to ground improvement performance verification. Only when performance verification of the Contractor's chosen ground improvement method has been completed to the entire satisfaction of the Employer, shall permission be given for the verified ground improvement techniques to be adopted in the Permanent Works.
- B1708.15.3 The Contractor shall closely monitor the progress of and maintain adequate resources to ensure the completion to the satisfaction of the Employer of his ground improvement performance verification works within the time-frame allocated in his programme. The Employer shall be immediately notified should it at any time appear that programme slippage is likely to occur and the Contractor shall take such steps as necessary to remedy the situation.

B1709 USING SHEET PILE AS REPLACEMENT TO RECLAMATION BUND

B1709.1 General

B1709.1.1 The work specified in this section covers the steel sheet pile wall in case it is proposed as a replacement to the reclamation bund. The intent of these specifications is to describe and cover mobilisation of all labour, materials and equipment necessary to accomplish all work and execute the works as specified and as shown on the guideline drawings for the works.

B1709.1.2 Installation of steel sheet wall (if proposed) shall be in accordance with the Specification.

B1709.1.3 Piles shall initially be driven using vibro-hammers to minimise noise. If vibro-hammer driving to the required toe level is not possible, switching to an impact hammer for the final stage of driving shall be permitted. The level at which the switch to impact hammer is made shall be agreed by the Employer.

B1709.1.4 The grades of steel are as described on the specifications.

B1709.1.5 All steel surfaces of the piles shall be completely dry and free from oil and grease and all welds ground smooth and weld spatter removed. All fins at saw cuts, burrs, and sharp edges shall be removed and the edges shall be rounded off.

B1709.2 Ordering of Piles

B1709.2.1 The Contractor shall ensure that the piles are available at the time for incorporation in the Works. All piles and production facilities shall be made available for inspection at any time.

B1709.2.2 Only new piles (hot rolled) shall be used for permanent works. Piles shall be carefully examined at the time of delivery and damaged piles repaired or replaced.

B1709.2.3 The records of testing of the steel used in the piles shall be submitted prior to commencing the Works.

B1709.3 Materials

B1709.3.1 All steel shall be in accordance with the contract drawings and the Specifications.

B1709.3.2 The sources of supply, the types of sections shall be submitted to Employer for approval before procurement. Materials failing to comply with the Specification shall be removed promptly from the site at no cost to the project.

B1709.4 Installation Procedure

The selection of driving and contracting plant shall be made having due regard to the ground conditions and pile type.

B1709.5 Pile Driving Equipment

B1709.5.1 Pile driving equipment shall conform to the following requirements.

B1709.6 Driving Hammers

B1709.6.1 Hammers shall be impact / vibratory type as per manufacturer's specifications. Pile driving hammers shall be correctly positioned on the pile so that the hammer is aligned as near to the axis of the pile as is practically possible. Freely suspended piling hammers shall be equipped with correctly adjusted leg guides and inserts. Where a hammer is mounted on a rigid leader, the leader shall be stable. The anvil block or driving plate shall be of sufficient size to cover as much as possible of the cross-section of the pile.

B1709.7 Placing

B1709.7.1 Pilings shall be carefully located as directed. Pilings shall be placed plumb with out of plumbness as per tolerance limit specified to manufacturer EN / ASTM specifications. Temporary wales, templates, guide structures shall be provided to insure that the pilings are placed and driven to the correct alignment. At least two templates shall be used in placing each piling and the maximum spacing of templates shall not exceed 6m. Pilings properly placed and driven shall be interlocked throughout their length with adjacent pilings to form a continuous wall throughout the length or run of piling wall.

B1709.8 Driving

B1709.8.1 Adequate precautions shall be taken to insure that pilings are driven plumb. If the forward or leading edge of the piling wall is found to be out-of-plumb, the piling being driven shall be driven to the required depth and tapered pilings shall be driven to interlock with the out of plumb leading edge. If approved, other corrective measures may be taken to insure the plumbness of succeeding pilings.

B1709.8.2 Pilings in each run or continuous length of piling wall shall be driven alternately, in increments of depth, to the required elevation. No piling shall be driven to a lower elevation than those behind it in the same run, except when the pilings behind it cannot be driven deeper. If the piling next to the one being driven tends to follow below final elevation, it may be pinned to the next adjacent piling. If obstructions restrict driving, a piling to the specified penetration the obstructions shall be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical, the Contractor shall make changes in the design alignment of the piling structure as directed to ensure the adequacy and stability of the structure. Pilings shall be driven to depths shown and shall extend up to the elevation indicated for the top of pilings.

B1709.9 Cutting-off and Splicing

B1709.9.1 Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance shall be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving shall be extended as required to reach the top elevation by splicing when directed at no additional cost to the Owner

B1709.10 Inspection of Driven Piling

B1709.10.1 The contractor shall inspect the interlocked joints of driven sheet piles extending above ground. If contractor find out that the sheet piles are out of interlock, then the sheet piles have to be removed.

B1709.11 Pulling and Re-driving

B1709.11.1 In the pulling and re-driving of piles, the Contractor shall pull selected pilings to determine the condition of the underground portions of pilings. Any piling pulled and found to be damaged to the extent that its usefulness in the structure is impaired shall be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition shall be re-driven when directed

B1709.12 Tolerances

B1709.12.1 For a steel sheet pile, the maximum permitted deviation in any direction of the pile centre from the sheet pile line specified in the Contract Documents shall not exceed 75mm;

B1709.12.2 The deviation from the true axis shall not be more than 1.5% for vertical piles.

B1709.12.3 Cut-off levels of sheet piles shall be within ± 25 mm of the required top level.

B1709.12.4 If forcible corrections are made to steel sheet piles the Contractor shall demonstrate to the satisfaction of the Employer that the integrity, durability and performance of the piles have not been adversely affected.

B1709.13 Damage to Piles

- B1709.13.1 The Contractor shall ensure that during the course of the Works, displacement or damage which would impair either performance or durability does not occur to completed piles.
- B1709.13.2 The sequence and timing for installation of piles submitted to the Employer for approval shall be prepared having regard to the avoidance of damage to adjacent bored piles.

B1709.14 Welding

- B1709.14.1 Welding shall be carried out by qualified persons and in accordance with this Specification.
- B1709.14.2 All welding shall be done with the prior approval of the Employer and the workmanship shall conform to the specifications of IS: 823 or other relevant Indian Standards as appropriate.
- B1709.14.3 When material thickness is 20 mm or more, special precautions like preheating shall be taken as laid down in IS: 823. Surfaces and edges to be welded shall be smooth, uniform and free from fins, tears, cracks and other discontinuities. Surface shall also be free from loose or thick scale, slag rust, moisture, oil and other foreign materials. Surfaces within 50 mm of any weld location shall be free from any paint or other material that may prevent proper welding or cause objectionable fumes during welding.
- B1709.14.4 The general welding procedures including particulars of the preparation of fusion faces for metal arc welding shall be carried out in accordance with IS: 9595.
- B1709.14.5 The welding procedures for shop and site welds including edge preparation of fusion faces shall be submitted in writing in accordance with Clause 22 of IS: 9595 for the approval of the Employer before commencing fabrication and shall also be as per details shown on the drawings. Any deviation from above has to approved by Employer. Preparation of edges shall, wherever practicable, be done by machine methods.
- B1709.14.6 Machine flame cut edges shall be substantially as smooth and regular as those produced by edge planning and shall be left free of slag. Manual flame cutting shall be permitted by the Employer only where machine cutting is not practicable.
- B1709.14.7 Electrodes to be used for metal arc welding shall comply with relevant IS specifications mentioned. Procedure test shall be carried out as per IS: 8613 to find out suitable wire-flux combination for welded joint.
- B1709.14.8 Assembly of parts for welding shall be in accordance with provisions of IS: 9595.

- B1709.14.9 The welded temporary attachment should be avoided as far as possible, otherwise the method of making any temporary attachment shall be approved by the Employer. Any scars from temporary attachment shall be removed by cutting, chipping and surface shall be finished smooth by grinding to the satisfaction of the Employer.
- B1709.14.10 Welding shall not be done when the air temperature is less than 10 degrees Celsius. Welding shall not be done when the surfaces are moist, during periods of strong winds or in snowy weather unless the work and the welding operators are adequately protected.
- B1709.14.11 For welding of any particular type of joint, welders shall qualify to the satisfaction of the Employer in accordance with appropriate welders qualification as prescribed in any of the Indian Standards IS: 817, IS: 1966, IS: 1393, IS:7307 (part I), IS: 7310 (Part I) and IS: 7318 (part I) as relevant.
- B1709.14.12 In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as to avoid distortion and minimise shrinkage stress.
- B1709.14.13 All requirements regarding pre-heating of parent material and interpass temperature shall be in accordance with provision of IS: 9595.
- B1709.14.14 Peening of weld shall be carried out wherever specified by the Employer:
- B1709.14.15 If specified, peening may be employed to be effective on each weld layer except first.
- B1709.14.16 The peening should be carried out after weld has cooled by light blows from a power hammer using a round nose tool. Care shall be taken to prevent scaling or flaking of weld and base metal from over peening.
- B1709.14.17 Where the Employer has specified the butt welds are to be ground flush, the loss of parent metal shall not be greater than that allowed for minor surface defects. The ends of butt joints shall be welded so as to provide full throat thickness. This may be done by use of extension pieces, cross runs or other means approved by the Employer. Extension pieces shall be removed after the joint has cooled and the ends of the weld shall be finished smooth and flush with the faces of the abutting parts.
- B1709.14.18 The joints and welds listed below are prohibited type, which do not perform well under cyclic loading.
- (a) Butt joints not welded throughout their cross-section
 - (b) Groove welds made from one side only without any backing grip
 - (c) Intermitted groove welds
 - (d) Intermittent fillet welds
 - (e) Bevel-grooves and J-grooves in butt joints for other than horizontal position.
 - (f) Plug and slot welds

B1709.14.19 The run-on and run-off plate extension shall be used providing full throat thickness at the end of butt-welded joints. These plates shall comply with the following requirements.

B1709.14.20 One pair of “run-on” and one pair of “run-off” plates from same thickness and profile as the parent metal shall be attached to start and finish of all butt welds preferably by clamps.

B1709.14.21 When “run-on” and run-off” plates shall be removed by flame cutting, it should be cut at more than 3 mm from parent metal and remaining metal shall be removed by grinding or by any other method approved by the Employer.

B1709.15 **Supervision**

B1709.15.1 A competent supervision shall be present to record the necessary information during the driving of piles. The data to be corded shall include:

- The identification of the piles & its dimensions
- The disposition of approved piling
- Driving equipment performance data
- Piling penetration rate data
- Top and bottom elevations of installed piling

B1709.15.2 The format of driving records shall be as directed by Employer’s representative.

B1709.15.3 Any deviation from the designed location, alignment of any pile shall be noted and properly reported to the Employer’s representative.

B1709.16 **Painting System**

B1709.16.1 All steel sheet piling shall be completely dry and free from oil and grease and all welds ground smooth and weld spatter removed. All fins at saw cuts, burrs, and sharp edges shall be removed and the edges shall be rounded off. All steelwork shall be blast cleaned by an approved method in accordance with BS EN ISO 8501-1 to achieve Swedish Standard SA 2.5. Average blast profile is to be 75 microns; below 25 microns or above 100 microns is not acceptable. After blasting, all spent shot or grit shall be removed by vacuum cleaning, or by air line and brush.

B1709.16.2 A blast primer shall be applied within four hours of the preparation. The Contractor shall put his proposals for such a primer to the Employer for prior approval. A paint coating system shall be applied.

B1709.16.3 The Contractor shall submit to the Employer for his approval details of a paint system that will meet the requirements of this specification.

B1709.16.4 In proposing a paint system for approval, the Contractor shall take into account the system's resistance to mechanical damage and abrasion as well as the exposure conditions. A minimum total dry film thickness (DFT) of 450 microns shall be applied.

B1709.16.5 Cathodic protection using sacrificial anodes with a design life of 15 years is to be provided for the new steel retaining walls.

B1709.17 **Codes and references**

B1709.17.1 All work shall be carried out strictly in accordance with the Technical Specifications, unless otherwise approved by Employer's representative in writing. The Indian Standard Codes application to this section shall include but not limited to the following:

B1709.18 **Indian Standards (IS Codes)**

IS 9527 (Part 3): Code of practice for design and construction of port and harbour structures: Part 3 Sheet pile walls

IS 2314: Specification for steel sheet piling sections

B1709.19 **American Society for Testing and Materials (ASTM)**

ASTM A 6/A 6M General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling

ASTM A 328/A 328M Steel Sheet Piling

ASTM A 572/A 572M High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A 690/A 690M High-Strength Low-Alloy Steel H – Piles and Sheet Piling for Use in Marine Environments.

B1709.20 **Eurocodes**

N 12063 Execution of special geotechnical work. Sheet Pile walls
(Minimum additional thickness of sheet pile required for likely corrosion for atleast 75 years shall be indicated. RCC covering to sheet piles above 0.00 level up to top of sheet pile including wailing beam shall be specified)

B1710 CATHODIC PROTECTION SYSTEM

B1710.1 General

B1710.1.1 The intent of this specification is to cover the Sacrificial type Cathodic Protection System for the steel sheet pile wall.

B1710.2 Scope

B1710.2.1 Procurement, assembly, inspection, testing at manufacturer's work, proper seaworthy packing, delivery, installation, commissioning, performance testing and handing over to the owner at site for complete cathodic protection system

B1710.2.2 Site survey and analysis related to the cathodic protection system

B1710.2.3 Monitoring of the system for period of one year during guarantee and beyond that optional (at the discretion of owner).

B1710.3 Codes & Standards

B1710.3.1 The cathodic protection system shall conform to the latest revision of following standards and code of practice as specified herein after

BS EN 12473 - General Principles of Cathodic Protection in Seawater.

BS EN 12495 - Cathodic Protection for Fixed Steel Offshore Structures.

DNV RP B401 - Det Norske Vertias Recommended Practice - Cathodic Protection Design.

ISO 10474 - Steel & steel products - Inspection documents.

NACE SP0387 - Metallurgical & Inspection Requirements for Cast Galvanic Anodes for offshore Application

B1710.4 Design Requirements

B1710.4.1 Cathodic protection in the immersed zone shall be provided by Aluminium-Indium-Zinc sacrificial anodes

B1710.4.2 The design life of the corrosion protection systems shall not be less than 20 years. Anodes shall be designed for the 20 years design life

B1710.5 Design Criteria

B1710.5.1 Anode shall be cast Aluminium-indium-zinc alloy. Anodes shall be installed on the pile immediately after pile installation by an approved attachments procedure.

B1710.5.2 Sacrificial anodes in immersed zone shall be slender type (i.e. anodes having a casting length more than four times the effective radius of the anode), with a full-length bent steel core. The anodes shall be configured in a “stand-off” mount in the immersed zone. The anodes shall be mounted by welding the steel cores (standoff bent pipe) to doubler plates attached to the structures.

B1710.5.3 Design Parameters

Parameters	Design Value (m CD)
Design Life	20 years
Anode type	Long slender stand off
Anode Length (L)	$L \geq 4r$; r is radius of cylindrical anode; for non-cylindrical anodes $r = c/2\pi$ where c(m) is the anode cross sectional periphery
Min. distance from protection object	0.30m
Protected Potential	-0.80 V Ag/AgCl/Seawater
Electrochemical anode capacity (Al-In-Zn alloy)	2,500 A.hr/Kg
Anode closed circuit potential (Al-In-Zn alloy)	-1.05 V Ag/AgCl
Anode utilization factor	0.90 (As per recommendation of DNV RP B401)

B1710.6 **Anode Specification**

B1710.6.1 The anode composition shall be in accordance with Table below.

Material	% by weight
Zinc	2.5-5.75
Indium	0.015-0.040
Iron	≤ 0.09
Silicon	≤ 0.012
Copper	≤ 0.003

Material	% by weight
Cadmium	≤0.002
Others	0.10 max(each)
Aluminium	remainder

- B1710.6.2 Slender anodes shall meet the physical requirements criteria stated in section 3 of NACE SP0387 which is as follows:
- B1710.6.3 Cast Galvanic Anode identification: Each cast galvanic anode shall be marked with the unique heat and sequence number. For heat treated anodes, a heat treatment batch number shall also be provided on each anode.
- B1710.6.4 Cast Galvanic Anode Weights:
- (1) Individual cast galvanic anodes of each type and of nominal weights greater than 50kg(110 lb) shall be within $\pm 3\%$ of the nominal weight or 2.3 kg (5 lb) whichever is greater.
 - (2) To confirm compliance with point no. 1 all anodes of nominal weight greater than or equal to 140 kg (310 lb) shall be weighed. For lighter anodes, a minimum of 10% of randomly selected anodes shall be weighed.
 - (3) The total contract weight shall be no more than 2% above and not below the nominal contract weight.
- B1710.6.5 Cast Galvanic Anode Dimensions and Straightness:
- (1) Cast galvanic anode mean length shall be within $\pm 3\%$ of the nominal length or ± 25 mm (1.0 in.), whichever is smaller.
 - (2) Cast galvanic anode mean width shall be $\pm 5\%$ of the nominal mean width.
 - (3) Cast galvanic anode depth shall be $\pm 10\%$ of the nominal mean depth.
 - (4) The diameter of the cylindrical cast galvanic anodes shall be $\pm 2.5\%$ of the nominal diameter.
- B1710.6.6 The straightness of the cast galvanic anode shall not deviate more than 2% of the anode nominal length from the longitudinal axis of the anode.
- B1710.6.7 To confirm compliance, a minimum of 10% of all anodes shall be dimensionally inspected.

B1710.6.8 Cast Galvanic Anode Insert Dimensions & Position:

- (1) Cast galvanic anode insert location within the anodes shall not deviate from nominal position more than 5% of the nominal anode width and length and 10% of the nominal anode depth. For inserts intentionally close to a surface of the anode material, these designated tolerances may be inappropriate and should be subject to separate agreement.
- (2) Cast galvanic anode insert cross-section dimensions shall comply with the appropriate specification for the insert material used.

B1710.6.9 Cast Galvanic Anode Insert Materials:

- (1) Cast galvanic anode inserts shall be fabricated from weldable structural steel plates or sections or from weldable steel pipe. When insert-to-structure weldability is an issue, special insert materials may be required and shall be specified by the user.
- (2) Rimming steels shall not be used.
- (3) The carbon equivalent of insert materials shall not exceed 0.41%

B1710.6.10 Cast Galvanic Anode Sections & Internal Defects:

- (1) The number and method of selection of cast galvanic anodes to be sectioned for detection of internal defects shall be at the specific request of the user, including progressive examination requirements.
- (2) Cast galvanic anodes shall be sectioned transversely by single cuts at 25%, 33%, and 50% of nominal length, or at such other agreed locations for a particular anode design.

B1800 PIPELINES AND SPECIALS FOR PRESSURISED NETWORKS

B1801 APPLICABLE CODES

B1801.1 The Codes and Standards listed herein are not comprehensive but only generic. All design and specifications shall be based on latest Bureau of Indian Standards' (BIS) Codes of Practice and its Publications including all applicable official amendments and revisions.

S. No.	Code No.	Description
1.	IS: 376	Safety Code for Excavation Work
2.	IS: 10500	Drinking water specification
3.	IS: 14846	Sluice valve for water works purposes
4.	IS 13095	Butterfly Valves
5.	IS: 4984	High Density Polyethylene pipes for water supply
6.	IS: 8360	Specification for fabricated HDPE Fittings
7.	IS 8008	Specification for moulded HDPE Fittings
8.	IS 2530	Methods of test for polyethylene moulding materials and polyethylene compounds GRP pipes, joints, and fittings for use for Potable Water Supply
9.	IS 4905	Methods for random sampling
10.	IS 7328	High Density Polyethylene materials for moulding and extrusions
11.	IS 7634	Laying and Jointing of Polyethylene (PE) pipes
12.	ISO 4427	Polyethylene Pipes for water supply-specifications
13.	IS: 8329	Specification for centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage
14.	IS: 9523	Specification for ductile iron fittings for pressure pipes for water, gas and sewage

S. No.	Code No.	Description
15.	IS: 11906	Recommendations for cement mortar lining for cast iron, mild steel and ductile iron pipes and fittings for transportation of water
16.	IS 780	Specification for sluice valves for water work purposes (50 to 300 mm size)
17.	IS 2906	Specification for sluice valves for water work purposes (350 to 1200 mm size)
18.	CPHEEO	Manual on Water Supply and Treatment, III edition, Ministry of Urban Development
19.	IS 2041	Steel Plates for Pressure vessels used at moderate and low temperatures
20.	IS 2825	Code for unfired pressure vessels

B1801.2 Chlorinated Polyvinyl Chloride (CPVC) Pipes (For Water line)

- B1801.2.1 CPVC pipes & fittings used in hot & cold potable water distribution system shall conform to requirement of IS:15778. The material from which the pipe is produced shall consist of chlorinated polyvinyl chlorides. The polymer from which the pipe compounds are to be manufactured shall have chlorine content not less than 66.5%.
- B1801.2.2 The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The pipes shall not have any detrimental effect on the composition of the water flowing through it.
- B1801.2.3 All fittings shall be of injection moulded CPVC socket type with BIS's certification mark and designated by the diameters of their sockets. All fittings shall in all respects comply with IS:7834 (Part I-VIII)

B1801.3 Ductile Iron and Fittings

- Ductile iron pressure pipes and fittings (Class K9) shall be IS 8329 and IS 9523 marked. All fittings shall be socketed unless specified otherwise.
- B1801.3.1 Handling, Transportation and Storage of Pipes
Handling, transportation and storage of DI pipes shall conform to relevant IS codes.

B1801.4 Installation

B1801.4.1 Supplying, laying, jointing, testing and commissioning of pipes shall conform to relevant IS codes, as applicable. At road crossings pipes should be encased in RCC pipes of larger diameter. The alignment of pipelines shown in drawings of the tender documents is only indicative and the exact alignment will be as per approved design by the Employer.

B1801.5 Joints

(a) Spigot and Socket Joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS 12820.

(b) Flanged Joints

Flanged joints shall comply with dimensions and drilling details shall be to BS EN 1092-2. All flanged joints between steel and ductile iron pipe work shall be electrically isolated joints. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts.

B1801.6 Internal Linings

B1801.6.1 Ductile iron pipes and fittings shall have a cement mortar lining, in accordance with IS 11906 or ISO 4179. The minimum thickness of the lining shall not be less than 4 mm.

B1801.7 External Coating

(a) Ductile iron pipes and fittings shall be zinc coated with bitumen over coating in accordance with the following specifications. Buried and Exposed pipes above ground and fittings shall also have a factory applied polythene sleeving.

(b) Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 200 g/m² as described in Clause 5.2 of ISO 8179.

(c) Bitumen coating shall be of normal thickness 0.07 mm unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II.

B1801.8 Bedding of Pipes

B1801.8.1 Bedding shall be as per CPHEEO guidelines. Under dry soil conditions, the pipe shall be laid over sand bedding. The thickness of bedding shall be 150 mm or 0.25x (Outer dia.) whichever is more. The pipe shall be supported from sides and covered up to a depth of 15 cm above the pipe crown with fine sand. The bedding material shall be well graded fine sand as per IS 383 suitably compacted/rammed for pipe. Under sub-soil water/sub merged conditions the pipe shall be laid over 15 cm thick bed of graded rounded gravels 100 % passing through 20 mm sieve, 20-25 % passing through 10 mm sieve and 100 % retained on 6 mm sieve and shall also be encased with 15 cm thick layer of graded rounded gravels. This cover of graded rounded gravels all around the pipe shall act as a filter.

B1801.9 Flushing and Disinfection

- (a) Pipeline carrying potable water and treated sewage shall be suitably disinfected before commissioning. The main shall be flushed prior to disinfection. 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. 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.
- (b) Underground mains and lead-in connections to system risers shall be flushed before connections made to piping in order to remove foreign materials which may have entered underground during the course of installation. The flushing operation shall be continued until water is clear.
- (c) Underground mains and connections shall be flushed at a flow rate of not less than 1620 ltrs. per minute. The pump, water and other equipment necessary for the flushing shall be arranged by the contractor at his own cost.

B1801.10 Hydro testing of pipes

B1801.10.1 Hydro pressure testing shall be done on the completed pipe length for a minimum pressure of 1.5 times the designed pressure for retaining period of 4 hours. The acceptance criteria for hydrostatic test are no permanent deformation of any part of the pipeline fitting or equipment's and there shall not be any leakage through any of the joints. The hydro testing shall be done in the presence of Employer and a report shall be made by the contractor and the same shall be signed by the contractor's representative and Employer and submit the same to Employer after the successful completion of the hydro test. All the necessary consumables, equipments, tools & tackles required for the testing & inspection shall be arranged by the contractor and no extra cost shall be paid for the same.

B1801.11 Installation of Valves

B1801.11.1 The installation of valves in the trench shall be such that it's top of spindle/hand wheel will always be at least 150 mm below from the ground level and precast cover in the chamber and as per appropriate IS codes.

(a) Sluice Valves

Sluice valves shall generally conform to IS 14846. All valves shall be resilient seated Sluice valve PN 16, non-rising type. Flanges dimensions shall be as per ASME B16.5 150#.

Hydro pressure testing has to be done for all the valves as per IS 13095 – 1991 including its latest, at the manufacturer's end and a report has to be submitted to Employer.

(b) Materials of Construction

S. No.	Components	Material
1	Body and Doors	Cast Iron : IS:210 Gr FG 220
2	Spindle	Stainless Steel: BS:970 Gr 431
3	Wedge Gate	CI (Fully vulcanized with EPDM rubber)
4	Bonnet Gasket	EPDM
5	O-Rings(Stem Sealing)	EPDM
6	Shoe and channel linings	Stainless Steel : BS:970 Gr 304
7	Internal Fasteners	SS 316

(c) Butterfly valves

Butterfly valves shall be of double eccentric and resilient seated type generally as per BS EN 593 and IS 13095. The valves in the pump rising main shall be electrically/pneumatically operated resilient seated mounted flanged/ wafer type Butterfly valve as per IS 13095:1991 PN 16/BS:5155 PN16 non-rising stem, as per specifications below:

S.No.	Pressure Rating	PN 16
1	Type	Flanged/wafer/lugged wafer type
2	Body	Ductile Iron ASTM A536 Internally and external Electro-statically applied epoxy resin of 250 microns min
3	Disc	316 Stainless Steel A STM A351, Type CF8M
4	Body Seat Ring	EPDM
5	Shaft and hand wheel	SS-410
6	'O' Ring	EPDM
7	Internal hardware	SS-316

Disc pins shall be stainless steel. Rings shall be bi-directional self-adjusting suitable for pressure or vacuum service. Removal and replacement of seals shall be possible without removing the operating mechanism, valve shaft and without removing the valve from the pipeline. Valve shafts shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs.

All valve spindles and hand wheels shall be positioned to give good access for operational personnel. Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The gear box shall be of worm and worm wheel design type, totally enclosed, grease filled and weather proof. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head of 1.15 times the specified rating. Valve and gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 200 N. All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation.

Valves shall be capable of closing against the maximum flow that can occur in system. The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It shall be secured to the discs by tapered stainless steel cotter pins.

Valves shall be provided with position indicator to show the position of the disc, mounted on the driven shaft end.

Rigid adjustable stop mechanism shall be provided within the gear box or elsewhere on the valve to prevent movement of the disc beyond the fully open or closed position (i.e. set points).

(d) Ball Valves

The Ball Valves shall conform to API 6D/ API FA. The flange end shall be ANSI B 16.5 150#. The port shall be full bore bi-directional type.

Material of construction shall be as follows:

- (i) Body: ASTM A 216 GR WCB
- (ii) Ball: ASTM A 217 GR CA 15 (Solid)
- (iii) Seat: PTFE
- (iv) Stem: ASTM A 276 GR 410

(e) Air Valves

Air valves shall be of the kinetic, double orifice type, tamper proof suitable for releasing or admitting air in large volume when pipe is being charged or emptied and to release accumulated air under pressure. Air valves shall comprise of cast iron body having faced and drilled flange at inlet and with two chambers each housing a ball. One chamber shall have small orifice plate and other a large orifice plate. Balls shall be of injection moulded plastic with high impact strength.

Material of construction of air valve shall comply with following requirement:

S. No.	Components	Material
1.	Body and cover	CI
2.	Stem	High tensile brass
3.	Float	Polycarbonate up to 50 NB / SS 304-above 50 NB
4.	Vent valve	Brass

S. No.	Components	Material
5	Low Pressure seat ring and face rings	EPDM
6	Gasket, seal ring, sealing face	EPDM
7	Nut/Bolts	Stainless steel-304
8.	Coating	Electro-statically applied epoxy resin- Internally and externally (min 250 micron)

(f) Non-Return Valve

The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.

Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.

Dual plate check valves shall conform to API 594 and API 598. They shall have metal to metal sealing. The spring action shall optimize the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition. Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.

The minimum body-wall thickness shall conform to those given in Table 1B of API Standard 594.

The face-to-face dimensions of valves (including valves with ring-joint facings) shall conform to those mentioned in Table 2B of API Standard 594.

The valve body shall be furnished with a clearly visible forged, machined-in, or die-stamped arrow to indicate the direction of flow through the valve.

Maximum permissible seat leakage is 7cc/Hr/cm nominal diameter of valve.

Material of construction of valves shall comply with following requirements

S. No.	Components	Material
1.	Body	ASTM, A 395
2.	Plate	ASTM, A 351 Gr CF8M

S. No.	Components	Material
3.	Hinge Pin /Stop Pin/wetted parts	SS. AISI 316
4.	Springs	SS. ASTM A 313
5	Seat	SS AISI 316
6	Retainer	SS-304

B1801.12 Civil Works

B1801.12.1 All the civil work shall be carried out in accordance with civil and structural specifications provided in tender and latest CPWD specifications.

B1801.13 Testing and Commissioning of Pressurized Networks

B1801.13.1 Testing and commissioning of pipeline and other associated structures should be carried out as per applicable standards and IS codes. Testing and commissioning shall be coordinated with the Employer.

B1900 SEWAGE SYSTEM

B1901 CODES

B1901.1 The Codes and Standards listed herein are not comprehensive but only generic. All design and specifications shall be based on latest Bureau of Indian Standards' (BIS) Codes of Practice and its Publications including all applicable official amendments and revisions.

S.No.	Code No.	Title / Specification
1.	IS: 14333	Specification for High Density Polyethylene pipes (HDPE) and fittings for the use for Sewerage
2.	IS: 7634 Part 2 and 3	Code of practice for Laying and Jointing of High Density polyethylene pipes (HDPE) piping system
3.	IS: 783	Code of practice for laying of Concrete Pipes

B1901.2 HDPE Pipes and Fittings

B1901.2.1 All pipes shall be IS 14333 (latest edition) marked. HDPE Pipes shall be PE-80; PN-8. HDPE shall be used for sewage collection. The pipes shall be ISI marked suitable for making butt fusion joints. High density polyethylene (HDPE) used for manufacture of pipes shall conform to designation PEEWA-45-TA-006 of IS 7328 1992. HDPE pipes shall be rodent proof.

- (a) HDPE pipes should be manufactured using virgin pre-compounded black PE resin as per ISO/TR 9080: 1992, which complies with the following requirements:
- (b) The resin also should have been certified by an independent laboratory of international repute like Bodycote/ Slevan/ Advantica for having passed 10,000 hour long term hydrostatic strength (LTHS) test extrapolated to 50 years to show that the resin has a minimum MRS of over 10MPa. There should not be any brittle knee at 80 Deg C before 5000 hours. Internal certificate of any resin manufacturer will not be acceptable.
- (c) The resin must have passed the resistance to Slow Crack Growth test as per ISO 13479. It should be certified by independent laboratories of international repute like Bechtel or Bodycote.
- (d) Resin should fully conform to the requirements of ISO 4427.
- (e) The resin shall be compounded with carbon black. The carbon black content in the material shall be within $2.5 \pm 0.5\%$ and the dispersion of carbon black shall be in line with relevant international standards.
- (f) HDPE Pipes should be with non-detachable, detectable feature as specified under and should be capable of working with industry standard radio detection equipment.
 - (i) Copper Wire Diameter: 1.20 mm +/- 0.02
 - (ii) Copper Wire Resistance: < 10.0 Ohms/Km. at 27 deg. C

B1901.3 Handling, Transportation and Storage

B1901.3.1 Handling, Transportation and Storage of HDPE pipes shall be done as per IS 7634.

B1901.4 Installation

B1901.4.1 Supplying, laying and jointing of pipes shall conform to relevant IS codes, as applicable. At road crossings pipes should be encased in RCC pipes of larger diameter. The alignment of pipelines shown in drawings of the tender documents is only indicative and the exact alignment will be as per design approved by the Employer. The HDPE Pipes shall be laid in accordance with the latest IS 7634.

B1901.5 Fittings and Specials

B1901.5.1 All HDPE fittings/ specials shall be fabricated in accordance with IS: 8360 (Part I & III). PE Injection moulded fittings shall be as per IS: 8008 (Part I to IX). All fittings/specials shall be fabricated or injection moulded at factory only.

B1901.6 Jointing

B1901.6.1 HDPE pipe shall have electro-fusion welding for diameter up to and equal to 160 mm and for higher diameters pipe shall be joined by butt-fusion welding as per applicable standards and manufacturer's instructions. Jointing between HDPE pipes and specials shall be done as per the latest IS: 7634.

B1901.7 Bedding

B1901.7.1 Bedding shall be as per CPHEEO guidelines. Under dry soil conditions the pipe shall be laid over 15 cm thick sand bedding. The pipe shall be supported from sides and covered up to a depth of 15 cm above the pipe crown with fine sand. Under sub-soil water/sub merged conditions the pipe shall be laid over 15 cm thick bed of graded rounded gravels 100 % passing through 20 mm sieve, 20-25 % passing through 10 mm sieve and 100 % retained on 6 mm sieve and shall also be encased with 15 cm thick layer of graded rounded gravels. This cover of graded rounded gravels all around the pipe shall act as a filter.

B1901.8 Flushing

- (a) Pipeline carrying sewage shall be suitably flushed in order to remove foreign materials which may have entered underground during the course of installation. Flushing operation shall be continued until water is clear.
- (b) The pump, water and other equipment necessary for the flushing shall be arranged by the contractor at his own cost.

B1901.9 RCC Pipes (NP3) with Polyethylene (PE) Lining

B1901.9.1 The RCC pipes with minimum 3mm thick PE lining. Manufacturing/ supplying, laying and jointing of all Reinforced Cement Concrete (RCC) NP3 pipes with PE lining shall be done in accordance with standard CPWD specifications and applicable IS codes and other standards. The pipes shall be manufactured as specified in IS 458: 1988 (latest amendment).

B1901.9.1 Handling, Transportation and Storage of Pipes

Handling, Transportation and storage of pipes shall be as per relevant IS codes.

B1901.10 Supplying, Laying and Jointing

B1901.10.1 Supplying, laying and jointing shall conform to relevant IS codes, as applicable. At road crossings pipes should be encased in RCC pipes of larger diameter. The alignment of pipelines shown in the drawings of tender documents is only indicative and the exact alignment will be as per design by the contractor after approval from the Employer.

B1901.11 Joints

B1901.11.1 Unless otherwise approved by the Employer, joints on spigot and socket concrete pipes shall be flexible and sealed with a rubber ring or flexible gasket which shall be approved by the Employer and shall withstand the various tests specified for pressure and non-pressure pipelines.

B1901.11.2 The physical characteristics of the rubber ring shall be appropriate to the type of pipe and joint supplied and in accordance with IS: 5382 and IS: 12820 (latest amendments).

B1901.12 Bedding of Pipes

B1901.12.1 The bedding for pipe shall be provided as per relevant CPWD standards, IS codes, CPHEEO manual and directions of Employer. The trench bottom shall be even and smooth with the help of 150mm thick sand so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may endure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continuous contact between the trench and the entire pipe barrel between socket holes.

B1901.12.2 Concrete cushion and encasement applicable only at jointing with cement concrete of specified grade, shall be constructed as per the details given in approved drawings or as directed by the Employer. The thickness of concrete shall be as specified as directed by the Employer.

B1901.13 Flushing

(a) Pipeline carrying sewage shall be suitably flushed in order to remove foreign materials which may have entered underground during the course of installation. Flushing operation shall be continued until water is clear.

(b) The pump, water and other equipment necessary for the flushing shall be arranged by the contractor at his own cost.

B1901.14 Manholes and Chambers

The manhole spacing in general shall be as per CPHEEO, which shall be specified in the construction drawings and at every junction, change in direction or change in diameter of pipe. The manhole dimensions and other details shall be as per CPHEEO.

B1901.15 Excavation

B1901.15.1 The excavation shall be true to dimensions and levels shown on the plan and in accordance with the specifications provided for Civil Works or as directed by the Employer.

B1901.16 Reinforced Cement Concrete (RCC) Work

B1901.16.1 R.C.C work for Manhole and slabs shall be as per cement concrete civil and structural specifications provided in tender, unless otherwise mentioned in concept drawings.

B1901.17 Foot Rests

B1901.17.1 Steps shall be provided inside the manhole for depth more than 1.2m. These shall be of minimum 6 mm thick plastic encapsulated as per IS: 10910 on 12mm dia. steel bar conforming to IS: 1786 having minimum cross section as 23mm x 25mm and over all minimum length 263mm and width as 165mm. Foot rest should have tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length of 138mm and suitable to withstand the bend test and chemical resistance test as per specifications and having manufacture's permanent identification mark to be visible even after fixing, including fixing in manholes with 30x20x15 cm cement concrete block 1:3:6.

B1901.18 Manhole Cover and Frames

B1901.18.1 All manholes shall be provided with S.F.R.C covers and frames and generally shall conform to IS-19292 (Part 1 and 2) and embedded in reinforced cement concrete slab. The frames of manhole shall be firmly embedded to correct alignment and level in RCC slab or plain concrete as the case may be on the top of masonry otherwise. The details for construction of manholes and spacing etc. should be followed, as given in relevant standards. The manholes cover details as below:

Sl. No.	Manhole Type	Load withstanding capacity	Suitable Locations
1.	L.D (Light Duty)	2.50 T	Footpaths, Two wheelers
2.	M.D (Medium Duty)	10.00 T	Light four wheelers
3.	H.D (Heavy Duty)	20.00 T	Heavy vehicles
4.	E.H.D (Extra Heavy Duty)	35.00 T	Heavy traffic roads

B1901.19 Drop Connections

B1901.19.1 Drop connections shall be provided between branch sewer and main sewer or in the main sewer itself in steep ground when the difference in invert levels of the two exceeds 60cms. Drop connections from branch sewer to main sewer shall be made outside the manhole wall with CI pipe tee connections, vertical pipe and bend at the bottoms. The top of the tee shall be finished up to the surface level and provided with a C.I. hinged type frame and cover 30cms x 30cms. The connection shall be embedded in cement concrete (1:2:4 mix) 15cms all-round the pipe and tee up to the surface chamber of the tee. For 450MM Dia. and above a steep slope can be provided to join in the last line. If the difference between the incoming and branch line is upto 1.5 m, the crown of both pipes should be at same level.

B1901.20 Civil Works

B1901.20.1 All the civil work shall be carried out in accordance with civil and structural specifications provided in tender and latest Central Public Works Department (CPWD) specifications.

B1901.21 Testing and commissioning of Sewer Network

B1901.21.1 Testing and commissioning of sewers, manholes and other associated structures should be carried out as per applicable standards and IS codes. Testing and commissioning shall be coordinated with the Employer.

B2000 DEMOLITION AND BREAKING-OUT WORKS

B2001 PRE DEMOLITION WORKS

- B2001.1 Before starting any demolition or breaking-out work the Contractor shall examine all available information, carry out surveys as he considers necessary, and submit method statements to the Employer covering the proposed works. Structural calculations in support of method statements shall be provided. All demolition work shall be carried out in accordance with Indian Standard Code of Practice IS 4130-1991 and any other relevant codes.
- B2001.2 The Contractor shall study the drawings of the existing structures. Based on these, the Contractor shall make his own assessment of the structures to be demolished. The Contractor may at his own cost undertake further investigations on site and carry out further tests if he so requires to satisfy himself as to the correctness or otherwise of the conditions of the structures to be demolished.
- B2001.3 The methodology of demolition, and the appropriate equipment and plant for carrying out the required demolition shall be decided by the Contractor based on the data made available and/or on his own further site investigations.
- B2001.4 The Contractor shall familiarise himself with the existing conditions at the site, tidal, wind, wave and other environmental conditions, prior to submission of his Tender.
- B2001.5 The Method Statement shall clearly show how the Contractor intends to carry out the required demolition, the form and condition of the structures to be removed, removal methods of any flammable or toxic material, sequence and method of demolition (with particular attention to working near or over water), and lines and levels.

B2002 EXTENT OF DEMOLITION

- B2002.1 The extent of the demolition and breaking-out works are shown on the Drawings or mentioned in the scope of work. Piles are to be cut to existing bed level. Piles of mooring dolphin are to be extracted.

B2003 CONTROL OF DEMOLITION

- B2003.1 The Contractor is reminded that many parts of the site must remain in operation during the demolition works. The Contractor shall take all necessary precautions to ensure that dust, noise or falling debris do not constitute a hazard to personnel, equipment, the structure, vehicular traffic, vessel and any shipyard activity. Effective means of cleaning and removal of dust and debris away from the working area shall be implemented continuously. Demolished material and debris shall not be permitted to fall into the sea where any work is carried out over water. Demolished material shall not be allowed to accumulate on scaffolding.

B2004 SERVICES AFFECTED BY DEMOLITION

B2004.1 It is generally the intention that the Employer shall remove all services that may be affected by the demolition prior to a section of works being handed over to the Contractor such that demolition may commence. The extent and number of sections/areas of work shall be agreed with the Employer prior to the work commencing.

B2004.2 There may be occasions where services cannot be removed by the Employer without the co-operation of the Contractor. Therefore, the Contractor shall be deemed to have allowed for liaison with the Employer and receive Employer approval prior to any demolition work being carried out in the vicinity of services. Before starting demolition, ensure that all removals and disconnections have been carried out.

B2005 SERVICES WHICH ARE TO REMAIN

B2005.1 Notify the Employer of any damage arising to services that remain from the execution of the works. Make all arrangements for repair to the satisfaction of the Employer. The Contractor shall bear any costs arising.

B2006 WORKMANSHIP

B2006.1 Demolish structure(s) in accordance with IS 4130-1991 and any other relevant codes

- Operatives must be appropriately skilled and experienced for the type of work.
- Site staff responsible for supervision and control of the work shall be experienced in the assessment of the risks involved and in the methods of demolition to be used.

B2007 GAS OR VAPOUR RISKS

B2007.1 Take adequate precautions to prevent fire or explosion caused by gas or vapour.

B2008 DUST

B2008.1 Reduce dust by periodically spraying demolition works with water and in accordance to the EIA report requirements. The Contractor shall refer Section 14 of the tender documents for the EIA requirements.

B2009 HEALTH HAZARDS

B2009.1 Take adequate precautions to protect all persons from health hazards associated with vibration, dangerous fumes and dust arising during the course of the Works.

B2010 STRUCTURE(S) TO BE RETAINED

B2010.1 Adequately protect parts of existing structure(s) which are to be kept in place. Cut away and strip out the minimum necessary, as shown on the drawings, and with care to reduce the amount of making good to a minimum.

B2010.2 Prevent debris from overloading any part of the structure which is not to be demolished.

B2011 DANGEROUS OPENINGS

B2011.1 Illuminate and protect with barricades as necessary.

B2012 UNFORESEEN HAZARDS

B2012.1 Inform the Employer of any unrecorded voids, tanks, chemicals, etc. discovered during demolition work.

B2012.2 Agree with the Employer, methods for safe removal, filling, etc.

B2012.3 The Contractor is expected to familiarise themselves with the existing record drawings, sketches, documentation etc. and to remove, fill etc. such items shown shall be deemed to be included.

B2013 COMPLETION

B2013.1 Clear away all debris in accordance with a "Environment Management Plan", or similar approved plan, and leave the demolition site in a tidy condition on completion.

B2014 MATERIALS ARISING

B2014.1 All material obtained as a result of jetty demolition shall be crushed so as to be able to use as fill for reclamation or subgrade. Steel reinforcement could be taken by the contractor for selling outside.

B2014.2 In undertaking demolition and Site clearance works, the Contractor shall comply with all environmental legislation and regulations applicable to the Works, including that debris/waste materials are only disposed of in approved landfill sites. The Contractor shall obtain at his own cost any approvals to be obtained from the relevant authorities prior to the commencement of demolition. The successful bidder is required to identify the dump area and take permissions, if necessary. Fee / charges, if any, will be borne by the Contractor.

B2014.3 If required by any authority, and prior to disposal, the Contractor shall at his own cost arrange for the testing of materials arising from demolition for that may be classified under existing regulations as hazardous waste/materials.

B2015 TEMPORARY SUPPORTS

B2015.1 The possibility of temporary loss of strength of members during repair shall be taken into account by the Contractor in his work methodology. Temporary propping and alternative load-bearing supports may be required prior to cutting back and removal of defective concrete and reinforcement. If temporary propping is required it shall remain in place until such time as the repair(s) to the member has gained its specified strength. The Contractor shall submit details any of proposed temporary works and supports to the Employer at least one week before installation of such temporary works.

B2015.1.1 The anticipated need for any temporary propping shall be brought to the attention of the Employer. The actual need for temporary propping shall be agreed following discussion between the Employer and the Contractor.

B2016 BREAKING OUT

B2016.1.1 The method of breaking out shall minimise damage to the concrete areas that remain. The Contractor shall submit for approval, details of the proposed methodology of removal for the different elements, together with details of his proposed equipment and staff, at least two weeks in advance of the proposed operation. Mechanical breakers may be used after careful consideration of current Health and Safety requirements and shall only be used in a manner that avoids damage to the retained concrete, structure and reinforcement. The Contractor must ensure that no material arising from the breaking out is allowed to fall into the sea/watercourse but should be collected at source for correct disposal to the maximum extent.

B2016.1.2 Any damage caused to the structures that are to remain shall be made good at the contractor's cost to the satisfaction and within a timescale agreed with the Employer.

B2017 PILE REMOVAL

All existing piles affected by the proposed works shall be removed or cut back to the approval of the Employer. The proposed method shall be agreed with the Employer on a structure by structure basis.

All existing piles affected by the proposed works shall be cut to existing bed levels or extracted as per requirement during work. Piles of mooring dolphin are to be extracted. Demolished material is to be progressively removed, as quickly as practically possible and area of work maintained presentable at all times.

B2100 WORKS NOT SPECIFIED

- B2101.1 All materials not herein fully specified and which may be offered for use in the Works shall be subject to the approval of the Employer, without which they shall not be used anywhere in the Permanent Works.
- B2101.2 The workmanship of works not herein fully specified shall be carried out as per relevant IS Specifications and in absence thereof shall be as per the best standard practice as approved by the Employer.

VOLUME-II
SECTION 6C
SPECIFICATIONS FOR MEP WORKS

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C100 VENTILATION SYSTEM

C101 FRESH AIR INTAKE AND EXTRACT LOUVRES

C101.1 All the louvers shall be rain protection type and shall be fabricated from extruded aluminum/G.I. section. The bottom louver shall be provided with extended lip to prevent rain water seepage inside duct/room. The louvers shall additionally be provided with heavy duty expanded metal (aluminum alloy) bird screen from within.

C102 VENTILATION FANS

C102.1 The contractor shall supply and install fans as described hereinafter and of capacities indicated in the design criteria.

C102.2 Test and rate all fans in accordance with the standards of the AMCA for Air Performance, Sound Performance. All fans must bear the AMCA certified rating seal. Make appropriate allowance for the effects on fans performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fans performance equals that specified.

C102.3 Balance all fan wheels and all other moving components statically and dynamically. Where coating is specified and it affects the balance of the fan wheel, perform balancing after the coating has been applied. Drill all fan shafts on the centerline to receive a tachometer.

C102.4 Belt driven fans shall be connected to the driving motor by means of an approved V-belt drive with adjustable sheaves, unless otherwise designated belt drives shall be designed for 50 % overload capacity and the motors for such drives shall be equipped with adjustable bases or slide rails.

C102.5 Bearing shall be self-aligning, grease lubricated, ball bearing type and shall be complete with grease fittings, extended for easy access where necessary.

C102.6 Weather proof hoods should provide for all motors and drives exposed to weather.

C102.7 Back draft dampers, gravity type shall be installed on the fans discharge of all fans discharging directly to the atmosphere.

C102.8 Fans are to operate steadily without pulsation at design conditions. Centrifugal fan characteristic curves must be such that the fan operation point falls below the point of no flow static pressure, to the right of the point corresponding to that of maximum mechanical efficiency and a 15% increase in static pressure over the specified results in not more than a 15% reduction in cfm and does not affect the stability of fan operation.

C102.9 Performance curves shall be submitted for each fan for approval.

C103 TOILET EXHAUST FAN CABINET UNITS

C103.1 Extract from toilet shall be by means of fan cabinet units with active carbon filter. Each unit shall comprise a casing constructed from galvanized sheet steel enclosing one centrifugal fans direct or belt driven electric motors. Motors shall have seal for life bearings and maximum speed of 1450 rpm. All units shall incorporate vibration isolator, back draft damper. The unit shall meet the sound requirement of the room where it is installed. For motor requirements refer to electrical specification. Ventilation units Starter panel shall be provided with sufficient potential free contacts and relays for enabling Remote on and off from AC plant control Room.

C103.2 Approved Makes of HVAC

S. No.	Item Description	Approved Makes
1	Exhaust Fans	Kruger/System air/Nicotra/Lau/Ostberg
2	Paints	ICI/Asian/Berger or equivalent
3	Stabilizer	V GUARD or equivalent

C200 PAINTING WORK

C201.1 All equipment shall be painted as specified under respective headings. The contractor has to get approval of the quality and colour of paints for all types of painting work.

C201.2 Colour scheme for the plant and equipment

- | | | |
|--------|---|-----------------------------------|
| (i) | Compressor | Battle ship grey |
| (ii) | Condenser | Battle ship grey |
| (iii) | Refrigerant discharge line | Red |
| (iv) | Refrigerant liquid line | Yellow |
| (v) | Steel supports | Black |
| (vi) | Electrical panels/
sub-panel/remote
Control console | Light grey or any approved colour |
| (vii) | Cable trays | Black |
| (viii) | Supports for ducts | Black. |

C300 FIRE PROTECTION SYSTEM, FIRE ALARM AND DETECTION SYSTEM

C301 SCOPE OF WORK

- C301.1 The scope of the work covers, supply of materials, installation, testing, commissioning and obtaining statutory approval from the local fire authority for Fire Hydrant system & Fire Alarm system.
- C301.2 The scope of the work covers, supply of materials, installation, testing, commissioning and obtaining statutory approval from the local fire authority for Fire Hydrant system & Fire Alarm system.
- C301.3 The scopes of work, in general shall include the following:
- (i) Fire Fighting Pumps & Accessories and related electrical works.
 - (ii) Fire Hydrant (Down comer & Hose reel) System.
 - (iii) Fire Alarm system.
 - (iv) Public address system and Signage's.
 - (v) Hand Appliances
 - (vi) Obtaining NOC/Approval/Completion Certificate from the Local Fire Officer.
 - (vii) The Contractor shall be responsible for the Supply & Installation of all the above mentioned Fire Protection Systems in accordance with the Specifications, Standards and the contract drawings / documents. The entire work shall be carried out strictly in accordance with the true Intent and meaning of the specifications and drawings taken together, regardless of whether the same may or may not be shown particularly on the drawings or described in the specification, provided that the same can be reasonably inferred from there.
- C301.4 Copies of drawings of buildings and schedule of quantities are enclosed in the tender document. All the equipment and installation shall conform to specifications contained in Indian Standards.
- C301.5 The installation of Fire Hydrant systems shall conform to norms as per relevant IS code & NBC. The scope of work also includes obtaining Initial and final approval/ NOC for the system from State Fire Department and liaison works with the department. All incidental expenses in connection with the same shall be borne by the contractor.
- C301.6 The bidder shall visit the site before submitting the tender and familiarize the work and nature of site condition.
- C301.7 Without restricting to the generality of the foregoing, the work shall include the following:
- C301.8 Hydrant System Covering the Jetty, Approach, FIC bays entire buildings as applicable and consisting of the following:

- (1) Fire Pumps- Minimum pressure of 8 Kg/cm² at the remotest Hydrant
- (2) Other piping system ancillaries such as Suction & Delivery Headers, Air Vessel, Pressure Gauges, Pressure Switches, and Panels etc. as required.
- (3) Suitable electrical panel and instrumentation for automatic operation of pumps as detailed in technical specification.
- (4) Cabling connections for the pump. The scope also includes supply of cables, starters, isolators and earthing for all pumps.
- (5) External and Internal hydrant system in the buildings as detailed in Specification and drawings.
- (6) All minor building work, such as cutting and making good the damages and filling up the hole in walls, floor with cement concrete, after laying the wet riser and sprinkler pipes.
- (7) Necessary supports and clamps for pipes for the fire fighting, in the buildings, pump room. Vibration elimination arrangements (anti-vibration pads) for main electric pump and standby diesel engine driven pump. Necessary masonry work/steel work for supporting hose cabinets for external (yard) hydrants.
- (8) Hand appliances.
- (9) Fire alarm system consisting of Manual call points, Hooters, Multi detectors, Fire Alarm panel and control cabling.
- (10) Public address system fully operational, integrated with the fire alarm system and consisting of Talk back units.
- (11) Doing the liaison works for obtaining statutory approvals from local fire authority, electrical inspectorate for the fire protection system.

C301.9 The scope of work will also include such other related works although they may not be specifically mentioned above and all such incidental items not specified but reasonably implied and necessary for completion of the job as a whole and as desired and as directed by the Employer.

C302 STATUTORY APPROVAL

C302.1 Obtaining of the statutory approval of drawings including initial and final approval for the entire system including fire alarm & detection system from fire and rescue department shall be under the scope of the contractor. The required fee and incidental expenses shall also be borne by the contractor. The contractor shall also be responsible for arranging inspections by local fire officer from fire & rescue department.

C302.2 Inspection and testing: The contractor at his own cost shall arrange for Inspection and Testing by an approved classification society (IRS, ABS, LRS, DNV, BV). The contractor shall indicate in his tender, name of the third party inspectors from the above list. The entire item supplied and work carried out should be inspected and certified by of the third party inspector. Payment to the TPI shall be borne by the contractor. Third party inspections shall be carried out at least for the following stages in connection with the work.

- Approval of drawings of the project.
- Material inspection and acceptance.
- Review of test certificate of machineries and components at manufacturer's premises.
- Welding procedure qualifications.
- Welder's qualification.
- Welding inspection.
- Review and certification of NDT.
- Cement lining of pipes including test block preparation and load test.
- Surface preparation and DFT of each coat of paint.
- Erection of facilities at site.
- Fabrication and Installation of firefighting system
- Hydrostatic pressure test and commissioning.
- Final inspection.

C303 FIRE HYDRANT SYSTEM

C303.1 Standards

C303.1.1 The manufacture, identification of material and testing of equipment covered in this specification shall comply with the latest editions as on date of opening of tenders of the appropriate standards of the following. Unless otherwise specified, Indian Standards are preferred. All the appliances and accessories shall carry IS or International certification and shall be of approved make. The following IS applying to this Section:

IS:5- 2004	Colours for ready mixed paints and enamels (Fifth revision)
IS: 325	Three phase Induction Motors (Fifth revision)
IS: 444 – 1987	General purposes rubber water hose (Fourth revision)
IS: 636	RRL hose pipe-Non-percolating flexible firefighting delivery hose (Third revision)
IS: 694	PVC insulated cables (light duty) for working voltage upto 1100 volts.
IS: 780	Cast iron sluice valve
IS: 823	Welding procedure

IS: 884	First aid hose reel-Specification for first-aid hose reel for firefighting (First revision)
IS: 900	Installation of motors
IS 901 – 1988	Specification for couplings, double male and double female, instantaneous pattern for firefighting (Third revision)
IS 902 – 1992	Specification for suction hose coupling for firefighting purposes (Third revision)
IS: 903 -1993	Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner (Fourth revision)
IS: 907 – 1984	Specification for Suction Strainer cylindrical type for firefighting purposes (Second revision)
IS: 908 -1975	Specification for Fire Hydrant, Stand Post Type (Second revision)
IS: 909 – 1992	Specification for underground fire hydrant, sluice valve type (Third revision)
IS: 1239	Mild steel, black ERW pipes up to 150 mm dia, with fittings. (Part 1)-2004 Specification for steel tubes, tubular and other wrought steel fittings Part 1: steel tubes (Sixth revision). (Part 2) -1992 MS tubes, tubular and other wrought steel fittings, Part 2 MS tubular and other wrought steel pipe fitting (Fourth revision).
IS: 1255	Code of practice for installation and maintenance of power cables.
IS: 1554	PVC insulated cables (heavy duty) for voltage up to 1100 volts. — do — for voltage 3.3 kV to 11 kV
IS: 1652	Batteries
IS: 2062	Steel for General Structural Purposes
IS: 2379 – 1990	Color code for identification of pipe lines (First revision).
IS: 3043	Code of practice for earthing.
IS: 3589	Mild steel, black ERW pipes 200 mm dia and above, with fittings.

IS: 3844 – 1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises (First revision)
IS: 4038 – 1986	Specification for Foot Valves for water works purposes (Second revision)
IS: 4928 – 1986	Specification for delivery valve for centrifugal fire pump outlets (First revision)
IS 4984	HDPE pipes
IS 4985	PVC pipes
IS: 5216	Guide for safety procedures and practices in electrical work.
IS: 5290-1983	Specification for Landing Valves (Third revision)
IS: 5312	Non return valve (Part I) - 1984 Specification for Swing check type reflex valves (Non return) for water works purposes: Part I single door pattern. (Part 2) -1986 Specification for Non-Return Valves for water works purposes: Part 2 multi door pattern
IS: 5578	Guide for marking of insulated conductors
IS: 5714 – 1981	Specification for Hydrant Stand-Pipe for Fire Fighting (First revision)
IS: 5959	Specification for polyethylene insulated PVC sheathed heavy-duty electric cables, voltage not exceeding 1100 V — do — voltage 3.3 kV to 11 kV
IS: 7098	XLPE insulated cables
IS: 7673 - 2004	Fire Fighting Equipment - Glossary of Terms
IS: 8757 - 1999	Glossary of terms Associated with Fire Safety
IS: 9972 - 2002	Specification for Automatic Sprinkler Heads for Fire Protection Service (First revision)
IS: 10221	Code of practice-coating & wrapping of underground mild steel pipelines
IS: 11101 - 1984	Specification for Extended Branch Pipe for Fire Brigade Use

IS: 12349 - 1988	Fire protection-safety signs
IS: 12407 - 1988	Graphic symbols for fire protection plans
IS: 12469 - 1988	Specification for Pumps for Fire Fighting System
IS 13095	Butterfly valve
IS: 13947	SDFUs
IS: 14846 – 2000	Sluice Valve for water works purposes (50 to 1200 mm size)
IS:14933 – 2001	High Pressure Fire Fighting Hose - Specification
IS:15051 – 2001	High Pressure Fire Hose Delivery Couplings - Specification
IS:15105 – 2002	Code of Practice for Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems
IS:15301 - 2003	Code of Practice for Installation and Maintenance of Fire Fighting Pumps

C303.1.2 Unless otherwise mentioned, all applicable codes and standards shall be of the latest editions as published by the Indian Standards and all other such as may be published by them during the tenure of the contract, and shall govern in respect of workmanship, properties of materials, installation and methods of testing. In case where suitable Indian Standards are not available, generally accepted codes and practices as approved by the Employer shall be adopted. Any minor changes or modifications directed by the Employer shall also be incorporated by the contractor during execution of the work without any additional cost to Employer.

C303.2 System Components

C303.2.1 The Hydrant system shall comprise of Fire pumps for pressurization with all required accessories including valves, special fittings, instrumentation, control panels and any other components required to complete the system in all respects.

C303.2.2 The Hydrant system shall be automatic in action. The system shall be kept pressurized at all times through Jockey pumps. The hydrants shall be placed at a regular spacing as shown in the drawings. The following accessories are proposed in each hydrant.

- (a) One no. gunmetal double headed hydrant valve.
- (b) Two nos. RRL Hoses of size 63mm dia x 15m long.
- (c) One no. gunmetal Branch pipe.

C303.2.3 RRL hose and gunmetal branch pipe will be accommodated in a hose box mounted on brick/concrete pedestals.

- C303.2.4 The hydrant risers shall be terminated with air release valve at the highest points to release the trapped air in the pipe work.
- C303.2.5 To compensate for slight losses of pressure in the system and to provide an air cushion for counteracting pressure surges/water hammer in the underground pipe work, Air Vessels shall be furnished in the pump room near fire pumps.
- C303.2.6 The firefighting system for the onshore area shall be fed from the fire water underground tank as shown in the drawings.
- C303.3 Fire Pump
- C303.3.1 Fire pump shall be vertical turbine type. Fire water pump shall be designed for sea water services and material of construction shall be as follows:
- | | |
|---------------------------------|---|
| Suction bowl/ bell mouth | : SS ASTM A 743 CF 3 M |
| Impeller | : SS ASTM A 743 CF 3 M |
| Shaft/ shaft sleeves | : SS 316 L |
| Shaft Couplings | : SS 316 L |
| Discharge elbow | : SS 316 L |
| Couplings for pump | : Forged/ cast steel |
| Bowl Bearings | : Cutlass Neoprene Rubber in SS 316 L retainers |
| Thrust bearings | : Antifriction |
| Line bearings | : self-lubricated type |
| Foundation nuts/bolts/fasteners | : SS 316 |
| Motor Stool | : SS 316 |
| Sole/ Base plate | : SS 316 |
- C303.3.2 Each of the main water pumps shall be capable of delivering min. 410 m³/ Hr and total head shall be min. 85 m. The main pumps shall be capable of discharging 150% of its rated discharge at a min. 65% of the rated head. The shut off head shall not exceed 140% of the rated head. For firefighting in onshore area one pump shall be diesel engine driven with suitable gear box and the other shall be electric driven, while in the case of jetty and approach, one additional motor driven pump shall be provided as a standby. Suitable strainer of SS 316L with cleaning arrangement shall be provided at the bottom.
- C303.3.3 The motor shall be of sufficient rating to couple with the Vertical Turbine Pump.

- C303.4 Diesel Engine
- C303.4.1 The diesel engine to be coupled with the fire pump shall be amply rated. The rating of the pump and the cooling system shall be such that the system will be able to work continuously for at least 6 hours under full load in ambient conditions without any overheating or other problems. The starting system shall be heavy duty batteries with chargers. The engine shall be provided with independent fuel tank of capacity to work continuously for at least 6 hours. The tank shall be mounted on suitable steel support. The engine shall be coupled with suitable flexible coupling to the gear box shaft with proper safety guards. The gear drive shall be provided with extra cooling system. The oil shall be cooled by circulating sea water. The cooling water has to be tapped from the discharge head of the pump and the material for cooling coil shall be SS 316. A suitable control panel shall be provided by the side in which the starting switch, all gauges and indicators are mounted. Meters shall be provided to indicate engine oil pressure, cooling water temperature and RPM. Necessary protection shall be provided for Low lube oil Pr., High water temp., Engine over speed etc.
- C303.4.2 The Engine shall be compatible with the Vertical Turbine Pump.
- C303.5 Ductile Iron (DI) Pipes and Fittings
- C303.5.1 Where ductile iron piping is specified, it shall be class K9 pipe and comply with IS 8329. Ductile iron fittings shall be class K9 fittings and comply with IS 9523.
- C303.6 Joints
- C303.6.1 Joint types shall meet the following requirements.
- C303.7 Flanged Joint
- C303.7.1 PN 20 pressure rated flanges shall be flat faced and shall conform to the requirements of BS 4504 Part 1 (or to ISO 2531 or BS EN 1092 or equivalent DIN standards which are compatible with BS 4504 Part 1 for the same nominal diameters) "Welded" means, that the flanges shall be welded to the pipes at the point of manufacture under factory conditions with inspection agency certification.
- C303.7.2 All bolts to be supplied with flanges shall be of SS 316 to the approval of the Employer. Flanged joints shall be complete with all nuts, bolts, gaskets and two washers per bolt. Protection of all bolts, nuts, washers etc. and the joint, as a whole shall be covered with Denso or equivalent paste, primer, mastic, tape and PVC or polyethylene outer wrapping to ensure the equivalent durability as for the pipe coating system.
- C303.7.3 Gaskets for flanges shall be inside bolt circle type, with dimensions complying with BS 4865 Part I, and be manufactured from material complying with BS EN 1514, BS 2494: 1990 Type W listed in the Directory of the Water Research Centre, UK or equivalent.
- C303.7.4 The Contractor shall be responsible for checking and ensuring that mating flanges are compatible in all cases, including where connections are required to pipe work and valves associated with pumping plant and inlet/outlet pipe work at service reservoirs or other structures.

C304 COATING AND LINING

C304.1 External Coating

C304.1.1 Pipes and fittings shall be externally coated as per specification mentioned in clause no C304.

C304.2 Internal Lining

C304.2.1 Internal surface protection shall be Cement mortar lining, Pipes and fittings shall be internally lined with cement mortar using ordinary Portland cement conforming to BS12 or Sulphate resisting cement conforming to BS 4072.

C304.2.2 The thickness of lining shall be minimum 6mm.

C304.2.3 Inside of socket shall be free of cement mortar lining and shall be coated with the material used for external coating. Internal lining shall be done in accordance with BSEN545, ISO4179, AWWA C104, or equivalent.

C304.2.4 Any damage to the coating system shall be repaired by the contractor in accordance with the written recommendations of the manufacturer of the coating system and to the approval of the Employer.

C304.3 Specification of Cement Mortar Lining

C304.3.1 **General:** - This section covers specification and details of materials, operation, tools, plants and labour necessary for the cement mortar lining of fire water pipe lines.

C304.3.2 **Mortar:** - The density of mortar shall be sufficient not to leave any voids so as to achieve water tightness. The thickness of lining shall be uniform 3/8" unless stated otherwise for all fire water pipes.

C304.4 Materials

C304.4.1 Sand: Sand shall be superior. It shall be clear from salt and other particles and shall confirm to IS: 383.

C304.4.2 Cement: Cement shall be Portland and Pozzolona (Natural) conforming to IS:1489. Hardened, partially hardened cement, dirty cement etc. shall not be used.

C304.4.3 Water: Water for mixing shall be fresh, clear and free from injurious amount of oil, acid, alkali, salt, organic materials etc.

C304.4.4 Equipments: Suitable mechanical equipments capable of mixing mortar and doing the lining work to a reasonable degree of uniformity with respect to thickness, density and strength shall be deployed.

C304.4.5 Mortar mix: Trial mix shall be made to arrive at a mix of cement and sand with strength similar to a minimum of 28 days strength in compression of 200Kg/cm². Testing and sampling shall be done as per IS 6441.

C304.4.6 Cleaning: The inner surface of the pipe shall be thoroughly cleaned of rust, dirt, oil, welding splatters etc. using sand / shot blasting.

C304.4.7 Lining: Mortar mix shall be placed within 30 minutes after water is added to the mix. Placing of mortar inside the steel pipe shall always be done with care at manufacture's work site with complete facility for carrying out such work. The concrete shall be consolidating by spinning, vibrating, spinning combined with vibration or other appropriate mechanical means. Mortar lining of any length of pipe shall be continuous and no unfinished surface shall remain exposed for more than 20 minutes. Finished lining shall be free from any honeycombing, cracks and irregularities.

C304.4.8 Joints, bends etc. shall be properly lined with cement concrete line by manual applications, toweling etc.

C304.4.9 **Curing:** Water curing of mortar lining shall be commenced after lining has set. Curing shall be done for 14 days. The mortar shall not be allowed to dehydrate

C304.5 Mechanical Properties

C304.5.1 The mechanical properties of pipes and fittings shall be as follows:

Minimum Tensile Strength	420 N/sq. mm
Minimum Bending Strength	590 N/sq. mm
Modulus of Elasticity	14 to 18 x 10 ⁴ N/sq. mm

C304.6 Hydrostatic Pressure Test

C304.6.1 Ductile iron pipes and fittings shall have working pressure of 16 bars and shall be in accordance with ISO 2531 or with BS EN 545. The standard classes of pipes and fittings shall be as follows unless otherwise stated.

Socket & Spigot Pipes	K 9
Flanged Pipes & all other fittings except tees	K 9
Tees and Cross	K 14
Flanges	PN 20

C304.6.2 Each pipe and fitting shall withstand the working hydrostatic test pressure given below:

Nominal Diameter (mm)	Hydrostatic Test pressure (bar)	
	Pipe	Fitting
80 to 300	75	38
350 to 600	60	24
700 to 1000	48	15
1100 to 1200	38	15

C304.7 Fitting Compatibility

C304.7.1 The Contractor shall supply the fittings manufactured by the same manufacturer of pipes, using the same kind of material and compatible standards. The Contractor shall also ensure the dimension compatibility of pipes, fittings and couplings.

C304.8 Valves and Fittings

- C304.8.1 Isolation Valve shall be Butterfly (Manually or motorized / Ball valve of Stainless steel 316L construction appropriate for sea water duty. Globe Valves shall be provided on the cope points and in the branch pipe for hydraulic balancing. All globe and check valves shall be made of Stainless steel 316L. All globe and balancing valves shall be provided with Locking out arrangement without any extra cost. An air release valve shall be installed between the services boundary limit and at the farthest most cope point, as directed by the Employer.
- C304.8.2 Cam lock coupling shall be provided at the cope point for connecting hose pipe, which is coming from the vessel. Cam lock coupling shall be made of Stainless steel 316.
- C304.8.3 The pressure reducing and sustaining valves shall be Bermad 730 or Cal-Val 50-01/650-01 or equivalent, as approved by the Employer,
- C304.8.4 Expansion joints shall be located as shown on the drawings. Expansion joints shall be of the metallic bellows type, designed and supplied by a manufacturer specializing in such items, and shall comply with the American Expansion Joint Manufacturer's Standard or other approved standard. The installation of each bellows, including the positioning of adjacent anchors and guides, shall be strictly in accordance with the manufacturer's recommendations.
- C304.8.5 Each bellows shall be designed in accordance with the following table:

Minimum pressure rating: Normal	700 DN	350 DN
	1000 kPa	
Maximum (pressure relief valve setting)	1800 kPa	
Minimum axial compression (from as-installed position)	75 mm	50 mm

- C304.9 Pipe Support
- C304.9.1 Tender drawings indicate schematically the size and location of pipes. The contractor on the award of the work shall prepare detailed working drawings, showing the cross-sections longitudinal sections, details of fittings locations of isolating and control valves drain and air valves and all pipe supports. The Contractor must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.
- C304.9.2 Pipe route marker will be at every 100m for buried pipe as advised by the Employer.
- C304.9.3 The contractor shall take care to keep the minimum distance between the services as per as good practices and applicable codes/ standards.
- C304.9.4 The Contractor shall be responsible for the primary and secondary supports for all pipes services.

- C304.9.5 The Contractor shall prepare fabrication drawings for piped services and primary and secondary pipe support identifying all unistruts, brackets, columns, pipe clamps, hangers, pipe support attachments, anti-thrust devices, concrete pedestals, vibration isolators etc. not shown on the Drawings. Following preparations of fabrication drawings, any subsequent additional primary & secondary pipe support identified shall be fabricated and installed as required. The Contractor shall be deemed to have allowed for all required pipe support in accordance with the appropriate standards. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
- C304.9.6 Primary pipe support comprises brackets attached to unistruts cast in concrete and steel columns. The contractor shall coordinate with the civil contractor and provide their requirements for any inserts/unistruts etc. to cast in concrete.
- C304.9.7 Secondary pipe support comprises pipe clamps securing pipes to the primary pipe support, hangers, pipe support attachments, hooks, anti-thrust devices, concrete pedestals etc. All metallic pipe support elements shall be grade 316L stainless steel.
- C304.9.8 All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fiber glass tissue, each layer laid in bitumen.
- C304.9.9 The Contractor shall also provide calculations for number of expansion joints, anti-thrust devices and their location to the Employer for approval.
- C304.9.10 Piping shall be properly supported on suspended from on stands clamps hangers as specified and as required. The contractor shall adequately design all the brackets, saddles anchor clamps and hangers.
- C304.9.11 Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. To permit free movement of common piping support shall be from a common hanger bar.
- C304.9.12 Pipe hangers shall be provided at the following maximum spacing or as per calculations provided by the contractor whichever is lower:

Pipe Dia. (mm)	Hanger Rod Dia. (mm)	Spacing between Supports (m)
80 to 100	12	2.7
125 to 150	16	3.6
200 to 300	19	5.3

- C304.9.13 Insulated piping where provided shall be supported in such a manner as not to put undue pressure on the insulation. 14 gauge metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending at least 15c.m on both sides of the clamps saddles or roller.

- C304.9.14 All pipe work shall be carried out in a proper workman like manner causing minimum disturbance to the existing services buildings roads and structure. The entire piping work shall be organized in consultation with other agencies work so that area can be carried out in one stretch.
- C304.9.15 Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings. The Contractor shall also coordinate with Structure works teams for any cutout/opening required in the structure.
- C304.9.16 The Contractor shall make sure that the clamps brackets saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
- C304.9.17 All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter.
- C304.9.18 The Contractor shall prepare fabrication drawings for piped services and primary and secondary pipe supports identifying all unistruts, brackets, columns, pipe clamps, hangers, pipe support attachments, anti-thrust devices, concrete pedestals etc. All pipe work supports shall be provided with anti-corrosive coatings suitable to resist the corrosive conditions of the work site.
- C304.9.19 Pipe route marker will be provided at every 100m for buried pipe or as advised by the Employer
- C304.9.20 The contractor shall take care to keep the minimum distance between the services as per as good practices and applicable codes/ standards
- C304.10 Seismic Design Consideration
- C304.10.1 Seismic design shall inter alia provide for all the requirements given below:
- C304.10.2 Equipment shall be anchored i.e. its motion restrained and isolated from vibration as called for below:
- C304.10.3 All equipment's and electrical panels shall be provided with restraints using resilient pads as shown in the drawings.
- C304.10.4 Anchor bolts/expansion anchors shall not be less than 12 mm in diameter with 100 mm length of embedment in concrete.
- C304.10.5 Seismic provisions for pipes and conduits shall be made by the contractor as part of this contract and contractor shall have to make all provisions to meet design requirements without any extra cost
- C304.10.6 Flexible connections shall be provided for all piping with equipment.
- C304.10.7 Flexible connections shall also be provided for all piping and their supporting system at points of crossing at the building separation joints.
- C304.10.8 Flexible connections/plenty of slack in wires and cables shall be provided at all connections with equipment and the same shall not be pulled tight.

- C304.10.9 Flexible connections/plenty of slack in wires and cables shall also be provided for all cabling and their supporting system at points of crossing at the building separation joints.
- C304.10.10 Longitudinal bracing shall be provided for all cable trays at about 10 m c/c using mild steel angles.
- C304.10.11 Static analysis shall be done as per the formula given below to establish the lateral force developed by an earthquake.
- $F_p = F_o \cdot I \cdot C_p \cdot W_p$
- Where,
- F_p = Horizontal seismic force developed in N.
- F_o = Seismic zone factor to be taken as 0.25
- I = Importance factor to be taken as 1.50
- C_p = Horizontal force factor
- = 0.75 for all equipment and associated conduit, piping and machinery rigidly mounted
- = 2.0 for all equipment and associated conduit, piping and machinery resiliently mounted
- C304.10.12 The value of C_p for elements, components and equipment laterally self-supported at or below ground level to be taken as two-third of the value given above.
- C304.10.13 The design lateral force determined using the above formula shall be distributed in proportion to the mass distribution of the element or component.
- C304.10.14 Forces determined using the above formula shall be used to design members and connections which transfer these forces to the seismic resisting system.
- C304.10.15 Forces shall be applied in the horizontal direction which results in the most critical loading for design.
- C304.10.16 Provisions for seismic requirements shall not be measured and paid for separately but shall be deemed to be a part of the equipment, piping, appliance, system etc.
- C304.11 Welding procedure
- C304.11.1 The welding procedure shall only be carried out by fully trained and experienced welders and shall conform to IS-823. Employer reserves the right to set the correct welding procedure, if not satisfied. The welding electrode shall be of reputed make and shall have suitable coating complying with relevant Indian Standards.
- C304.12 Hydrant valves
- C304.12.1 The valve shall be double headed type with double outlet as per IS: 5290 unless otherwise specified in this specification. The outlet shall be inclined at 60° downwards from horizontal. The valves shall have two 63 mm dia. Instantaneous type female outlet with necessary blank cap. Any reference of Indian/International standard shall always be of latest revision.

- C304.12.2 The bottom (inlet) flange of valve shall be of 4 inch nominal size SOFF. The drilling dimensions shall be as per ANSIB 16.5,150 # rating.
- C304.12.3 Branch pipe, nozzle and valve shall be made of brass
- C304.12.4 The flow shall not be less than 1800 lpm (900 x 2) at 7 Kg/cm2.
- C304.12.5 The valve top except the face of the flange and the instantaneous outlet shall be painted with fire red paint. The instantaneous outlet shall be highly polished. The hand wheel shall be painted black.
- C304.13 Gate Valve
- C304.13.1 All the gate valves shall be of approved make.
- | | |
|-----------------|---|
| Rating | : ANSI 150 Class |
| Body | : CS ASTM A 216 Gr WCB |
| Wedge | : SS 316 |
| Spindle | : SS AISI 410, Rising Type |
| Body Seat Rings | : Carbon Steel with 13% Cr., SS facing |
| Hand Wheel | : Malleable iron/ Ductile Iron/ steel, Non-rising type. |
| Bonnet-Gasket | : SPW SS 316 with CAF |
| Nuts and bolts | : SS 316 |
- C304.13.2 Flanges shall be as per ANSI B 16.5. Valves shall have the approval of BIS/FM. And shall be internally coated with epoxy powder
- C304.14 Hose reel
- C304.14.1 The hose reel shall consist of 30 m long 20 mm dia. Thermoplastic (Textile reinforced) Type-2 water hose as per IS: 12585 mounted on heavy duty circular MS drum complete with gun-metal shut-off valve, nozzle, etc. The hose reel bracket shall be of GI fabricated or cast iron swing type suitable for 90 deg. smooth and free rotation in vertical plane conforming to IS-884.
- C304.15 Hose boxes
- C304.15.1 The fire hose boxes shall be of size 900/750x250x600 mm, made out of powder coated MS sheet of minimum 2mm thickness front side glass of 6 mm thick, lockable hinged door. All external hydrants hose box shall be openable with one key and all internal hydrant also with one key. The lock shall be uniform type for external type boxes and internal type boxes.
- C304.16 Couplings
- C304.16.1 All couplings shall be of the instantaneous spring-lock type and the nozzles shall be of not more than 16 mm in dia. All couplings in the branch pipes and nozzles shall be of gunmetal and shall comply with IS-903. The hose shall be attached to the coupling. Spare hose and nozzles to the extent of 10 % of the total requirements shall be supplied by the contractor as per BOQ.

- C304.17 Fire brigade outlets/ Inlets
- C304.17.1 The fire brigade collective breaching shall be with 100 mm flange outlet connection with gunmetal twin-Siamese collecting head having 2 instantaneous outlets with built-in check valves. The fire brigade breaching shall be connected to the sump and the main header.
- C304.18 Delivery Hose
- C304.18.1 Delivery Hose for firefighting shall be of 63mm dia, 15mtr. long RRL hose pipe with 63mm dia Male and Female Gun metal couplings duly binded with MS wire, rivets etc. conforming to IS 636 (type-A)
- C304.19 Non Return Valve (NRV)
- C304.19.1 All the NRV in water line shall be of approved make and conforming to BS 1868 – Class 150. The material composition shall be as under.
- | | |
|--------------------|--|
| Body/ Bonnet | : CS ASTM A 216 Gr WCB |
| Disc/ Wedge | : SS 316 |
| Trim | : SS 316 |
| Body and seat ring | : Carbon Steel with 13 % Cr., SS facing |
| Bonnet- Gasket | : SPW SS 316 with Compressed Asbestos Filler (CAF) |
| Nuts and Bolts | : SS 316 |
- Flanges shall be as per ANSI B 16.5
- C304.19.2 Pressure class shall be of PN 20 for water purpose. All valves shall be internally coated with epoxy powder.
- C304.20 Pressure gauges
- C304.20.1 It shall be of dial type with Bourden tube element of SS 316. The dial size shall be 150 mm dia. and scale division shall be in metric unit marked in black on white dial. It shall be comprised with snubber, isolation coke, nipples, tail, connecting pipes, etc.
- C304.21 Pressure switches
- C304.21.1 It shall be of industrial type, single pole, double throw electric pressure switching designed for starting or stopping equipment within the pressure of the system drops or exceeds the pre-set limits. All switches shall have ¼” BSP (F) inlet connection and screwed cable entry for fixing cable gland. The pressure switch shall have a rating of 4-20 kg/cm² with 0.8 to 3 kg. Differential pressure setting. Maximum working pressure shall be 28 kg/cm² with auto reset.
- C304.22 Foot valve
- C304.22.1 The valve shall be of globe style with cast steel body and bronze trim. The disc of the valve shall open at a minimum pressure of 0.035kg/cm²

C304.23 Butterfly Valves

C304.23.1 The butterfly valve shall be wafer type to suit the flanges as per ANSI B 16.5 #150 standards. The body shall be of cast steel with Bronze/Gunmetal seat duly ISI marked completed with nuts, bolts, washers, gaskets conforming to IS 13 095. The PN rating shall be of 20. The valve shall be hand lever operated.

C304.24 Ball Valve

C304.24.1 The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections. The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon. The handle shall be provided with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the Teflon packing shall be sealed to prevent water seeping. The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

C304.25 Air Release Valve

C304.25.1 The air release valve shall be designed to automatically remove air pockets at the high points. The valve shall be a normally open valve and will slowly release air through the top orifice. As fluid enters the valve, the float will rise, closing the orifice. As air accumulates in the piping system and enters the valve the float drops allowing the venting orifice to open. The working pressure shall be 15 kg/cm²

C304.26 Orifice Plate

C304.26.1 Orifice plate shall be made of minimum 6 mm thick stainless steel with orifice of required size in between flange and landing valve to r

C304.26.2 Reduce pressure to working pressure of 3.5 kg/cm². The item shall be complete with fixing arrangements etc.

C304.27 Sprinkler System

C304.27.1 Sprinkler system shall be provided

- (i) in the basement if its area exceeds 200 m².
- (ii) above the false ceiling if false ceiling void is having height greater than 800 mm.
- (iii) in the regions where the size of single compartment exceeds 750 m².
- (iv) in any other region as ordered by the Authority having Jurisdiction.

C304.28 Standard Sprinklers

C304.28.1 The standard sprinkler system shall be designed for a discharge density of 5 lpm/Sq.m (moderate hazard building) and Assumed Maximum Area of Operation (AMAO) is 360 Sq.m. The minimum sprinkler discharge pressure shall be 3.5 bar and 'K' factor shall be 80. Sprinkler shall not be reconditioned or repaired. Defective sprinklers shall be replaced with new ones. Sprinklers and multiple controls shall not be painted except for the identification purpose. Sprinklers shall be of 'Upright' or 'Pendant' type depending upon whether it caters space above or below the false ceiling. Sprinklers shall have temperature rating for 68 deg. C with Red colour code. It shall be of Quartzoid Bulb suitable for installation indoor as well as outdoor.

C304.29 Arrangement of sprinklers

C304.29.1 Sprinklers shall be installed with the deflector parallel to the floor. Sprinklers shall be not spaced at less than 2 m. The distance between the boundary and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing between the sprinklers and range pipes. As far as possible, sprinklers shall be located away from the columns. Sprinklers shall not be connected directly to distribution and main pipes. Sprinklers shall not be provided in the following areas of the building:

- (1) Stairs, spaces below stair headings.
- (2) Toilets.
- (3) Rooms containing electric power distribution apparatus.
- (4) Control rooms.

C304.29.2 Number of sprinklers that can be installed on range pipes is as given below:

- 25 mm dia. Range pipe: 2 nos. max.
- 32 mm dia. Range pipe: 3 nos. max.
- 40 mm dia. Range pipe: 4 nos. max.
- 50 mm dia. Range pipe: 9 nos. max.

C304.29.3 Number of sprinklers that can be installed on distribution pipes is as given below:

- 32 mm dia. distribution pipe: 3 nos. max.
- 40 mm dia. distribution pipe: 6 nos. max.
- 50 mm dia. distribution pipe: 9 nos. max.
- 65 mm dia. distribution pipe: 18 nos. max.

C304.30 Alarm valve

C304.30.1 Alarm valves shall be fitted on the main supply pipe immediately above the main control valve leading to the sprinkler installations. The alarm valve shall have the following accessories:

- Main Stop Valve - 1 No. shall be fitted immediately downstream of the alarm valve. and shall be at fire brigade access level.
- Test Valve - 1 No. shall be provided to test the hydraulic alarm or any electric alarm pressure switch if provided by drawing water from the downstream side of a wet alarm valve. It shall be installed close to the alarm valve.
- Drain valve - 1 No. shall be fitted to allow drainage from immediately downstream of the alarm valve.
- Water motor alarm - 1 No. shall be fitted as close as possible to the alarm valve. It Shall be installed with its gong on the outside of an exterior wall. A Strainer readily accessible for cleaning shall be fitted between the Motor nozzle and alarm valve connection. The water outlet shall be positioned so that any flow of water can be seen. The pipe work to the water motor shall be galvanized. Any device to reduce the frequency of false or intermittent alarms fitted to the installation shall be suitable for sprinkler service.
- Pressure gauge - 1 No. Shall be fitted immediately downstream of alarm valve. Pressure gauges fitted shall comply with relevant IS Standards. The scale sub-division shall not exceed 0.2 bar for a Maximum scale value up to and including 10 bar.

C304.31 Flow Switch

- C304.31.1 The flow switch shall be of Paddle type with SPDT contacts, with fixing accessories suitable for nominal pipe dia meters ranging from 1" to 6". The material of the construction of the paddle shall be of stainless steel or copper alloy. The body of the flow switch shall be water proof with IP55 class protection. There shall be inbuilt settings to adjust the flow rate and alarm retard time. While installing a minimum clearance of 5 pipe dia meters should be ensured from the nearest elbow, valve or other pipe restrictions. The flow switch should have minimum withstand pressure of 15Kg/cm² and operating pressure ranging from 1 kg/cm² to 17 Kg/cm².

C304.32 Supports for sprinkler piping system

C304.32.1 Sprinkler pipes shall be supported from the building structure, wall/truss/ purlin and shall not impair the performance of sprinklers under fire conditions. Pipe work shall not be used to support any other loads. Supports shall not be welded or fastened directly to the pipe work. The thickness of pipe supports shall not be less than 3 mm. The weight of pipes filled with water shall be considered for design of structural supports for pipes. Wherever possible; pipes shall be supported from non-combustible building elements. Pipe works in corrosion areas shall be of either stainless steel or suitably protected against corrosion. Standard pipe hangers such as solid ring, swivel ring, clip, band hanger, bracket, ceiling flange, clamp, etc. shall be used for supports. The spacing between the pipes supports measured along the line of connected pipes shall not be more than the following:

Pipe (MM)	Spacing (MTR)	Size of support
Up to 25	2.0	6 mm
32 to 65	2.4	8 mm
75 to 125	2.7	10 mm
150 & above	3.0	12 mm

C304.33 Welding procedure

C304.33.1 The welding procedure shall only be carried out by fully trained and experienced welders and shall conform to IS-823. Employer reserves the right to set the correct welding procedure, if not satisfied. The welding electrode shall be of reputed make with ISI mark, and shall have suitable coating complying with relevant Indian Standards. Welded joints shall not be permitted for pipes having diameter less than 50 mm, but it shall be screwed using sockets.

C304.34 Corrosion Protection

C304.34.1 The Contractor shall ensure that all equipment, material, accessories and supports used for the project shall be resistant to corrosion and/or provided with anti-corrosive coating under the aggressive sea environment at the project site, as approved by the Employer.

C304.34.2 All struts, fasteners, etc. to be grouted into the concrete shall be Stainless steel SS316

C304.34.3 Contact of Dissimilar items shall be avoided. Appropriate coatings and gasket material shall be used to avoid the contact of dissimilar material.

C304.34.4 SS316L material may not require the protective coating. All other material shall be provided with the protective coating as given below.

C304.34.5 **Surface preparation:** The entire surface of the new pipelines and fittings have to be sand/ shot blasted thoroughly with SA 2 ½ specification to the original surface condition and then be painted as per the following pattern.

No.	Coating	No. of Coats	Total DFT
1	Zinc ethyl silicate primer	1 coat	60 – 70 µm
2	Epoxy – MIO under coat	1 coat	100 – 110 µm
3	Polysiloxane finish coat	1 coats	100 – 125 µm
4	Total thickness	3 coats	260 – 305 µm

C305 SPECIFICATION OF COATINGS

C305.1 Zinc ethyl silicate primer

Colour	: Grey
Finish	: Matt
Type	: Two pack
Application	: By spray (Air or Airless)
Dry film thickness/coat	: 60 – 70 µm
Volume solids	: 60 – 3%
Surface dry	: 2 hrs.
Hard dry	: 24 hrs.
Recoatibility	: 24 hour

C305.2 Epoxy – MIO High Build

Colour	: Dark brown
Finish	: Matt
Type	: Two pack
Application	: Brush or Spray
Pigment (main)	: Micaceous iron oxide (MIO) 55% w/w of the total pigment.
Dry film thickness per coat	: 100 – 110 µm
Volume solids	: 60 ± 2 by volume
Drying time	: Surface dry 2 hours
Recoat ability	: 24 hours

C305.3 Poly Siloxane Finish coat

Colour	: Post Office Red
Finish	: Glossy

Type	: Two packs
Application	: By brush or Air/Airless spray
Volume solids	: 75 ± 1%
Dry film thickness/coat	: 50– 60 µm
Pot life	: 1.5 hour
Surface dry	: 2 hrs.
Hard dry	: 24 hrs.

- C305.4 This specification defines the requirements for surface preparation, selection and application of paints on piping, steel structure etc.
- C305.5 Pipes shall be painted only after completion of fabrication. Wherever possible complete painting of pipeline shall be carried out in the fabrication shop itself.
- C305.6 The paint manufactures' instruction shall be followed at all times. Particular attention shall be paid to the following.
- (a) Proper storage to avoid exposure, as well as extremes of temperature.
 - (b) Surface preparation prior to painting.
 - (c) Mixing.
 - (d) Application of paints and recommended limit on time interval between coats.
- C305.7 All painting materials including primer and thinner brought to the site by the contractor for application shall be one of the following Make/Brand.
- (a) Akzo Nobel
 - (b) Zigma
 - (c) Jotun
 - (d) Asian Paints
 - (e) Berger

C306 INSPECTION AND TESTING (FIRE HYDRANT SYSTEM)

- C306.1 Inspection
- C306.1.1 All site fabricated work/ material shall be subject to inspection in cleaned condition, prior to erection. At no event, site fabricated work /material shall be installed in position without inspection and approval by the Employer. The Contractor shall ensure that each stage of fabrication is carried out in compliance with the procedures specified in the IS / NBC standards as applicable and/or specified in this document.

- C306.1.2 The contractor shall conduct sample tests of all the materials supplied at reputed laboratories/agencies as directed by Employer at his own cost and test reports are to be submitted. Inspecting officials of Employer and Local Authorities shall have the right to access the premises of the work at any time with or without giving prior notice. All the formalities or procedures for conducting the inspections by the authorities as required by them shall be arranged by the contractor free of cost.
- C306.1.3 All testing shall be carried out in the presence of Employer/ statutory authorities and test registers shall be maintained by the contractor. The contractor shall provide all material, tools, equipment, instruments, services and personnel required to perform the tests and remove debris/water resulting from cleaning and after testing free of cost
- C306.1.4 The original test certificates of all tests conducted are to be forwarded to Employer. After conducting the tests, any defects found on materials, equipment, piping, etc. shall be got rectified/repaired by the Contractor without any extra cost.
- C306.2 Testing
- C306.2.1 Before energizing electrically operated equipment, care shall be taken to meet the local electrical rules and regulations, earthing of the body, verifying availability of safe insulation resistance value, etc. Also confirm the motor enclosure to the level of protection required for the particular application.
- C306.3 Pumps
- C306.3.1 The pumps shall be tested according to the standard recommendations of the manufacturer. The following parameters are to be recorded and plotted and submitted to the Employer.
- (a) Discharge Q
 - (b) Pressure P or Head H
 - (c) Motor voltage and current.
 - (d) Efficiency
- C306.3.2 The power consumption is to be computed and crosschecked with manufacturer's data. Any abnormalities, if noted, shall be brought to the notice of the manufacturer and necessary corrective action be taken before commissioning and handing over, without any extra cost. Manufacturers test certificates shall also be submitted to Employer for verification.
- C306.4 Piping
- C306.4.1 All piping shall be tested by filling water, removing air locks, foreign materials, etc. and applying pressure at 1.5 times of the maximum working pressure and see that the pressure drop is within 0.5 Kg per Sq. cm over a period of 2 hours. The testing shall be carried in sections by blocking both ends or closing the valves provided. After completion of the installation and connecting to the mains of pumping system the installation shall once again tested and rectify breakage if any or replace the defective material, free of cost.

- C306.4.2 At least 10% of the total weld joints on pipes shall be tested by radiography. Holiday tests shall preferably be carried out by flexible and detachable ring probe, which shall enable the entire 360 deg. of the surface of the pipe to be scanned.
- C306.5 Installation of Piping
- C306.5.1 Wherever piping are taken through road crossings etc., shall be protected by running through Hume pipes or ducts. Depth shall be 1200 mm from top of finished road surface and as per codal requirement.
- C306.6 Tests for Electrical system
- Earth resistance
 - Cable Insulation
 - Trial run and testing of diesel engine.
 - Resistance of metal conduits/sheaths (Earth continuity test)
 - Insulation of the cables shall be not less than one mega ohm when tested with a 500 volts meggar for any particular section of the wiring.
 - In case of cables encased in metal conduit or metallic sheathing, the total resistance of the conduit or sheathing from the earthing point to any other position in the completed installation shall not exceed 2 Mega Ohms.
- C306.7 Hydrant system
- C306.7.1 The entire hydrant system shall be tested in the presence of Employer to ascertain the functioning of each system, equipment, etc. as desired by Employer. The contractor shall hand over the system only if it is proved that the system performs as per the specifications.
- C306.8 Operation of pumps
- C306.8.1 The pumps shall be operated by both auto /manual modes and shall have automatic starting and stopping arrangements to maintain the system pressure.
- C306.8.2 Pumps when under “manual” status shall be operated manually through relevant push buttons.
- C306.8.3 The starting of terrace/booster pump should be automatic with pressure switch incorporated in down-comer side so that with opening of any hydrant valve or hose reel, it will start automatically with fall in line pressure. In addition, there should be a manual push button starter in the starter control panel to be located on ground floor of building. Stopping of pump should be by a push button located in the same starter control. Both the push buttons should be prominently indicated and should be in different colour for easy identification.

- C306.8.4 The contractor shall carry out necessary arrangements for supply and installation of items required like timer switches, sensors, cables, etc. and control wiring between pressure switches and panels to operate the pumps as described above. The cost for the same shall be included in the total contract value.
- C306.9 Approval from statutory authorities
- C306.9.1 It is responsibility of the contractor to get initial and final approvals / NOC for systems like electrical, fire protection system, etc. from the concerned departments /local bodies. The contractor shall also do all the liaison works with the departments for getting the approvals/ NOC. All the incidental expenses in connection with the above shall be borne by the contractor with no extra cost to the Employer. For all approvals / NOC, statutory fees shall be paid by the contractor initially; however, it shall be reimbursed on submission of documentary evidences.
- C306.9.2 All testing/calibration, etc. are to be carried out as per the requirements of statutory authorities at no extra cost to Employer. The tests/calibration certificates shall be submitted, if required.
- C306.9.3 On completion of work, the contractor has to obtain necessary safety /energization certificate from EI / local bodies by submitting necessary completion certificates, drawings, equipment details, load details, test results, etc. before energization.
- C306.10 System Commissioning
- C306.10.1 After the completion of testing and obtaining statutory approval, the system shall be commissioned. During commissioning the contractor shall establish the head, discharge, efficiency, drive connected load etc. of the pumps. The discharge from the hydrant valves, sprinklers etc. shall also be demonstrated. The commissioning will be for a continuous period of 1-7 days. The system shall be put in automatic mode and checked. The automatic operation shall be verified by releasing system pressure by opening of valves. Sprinkler system shall be tested by opening the drain valve. Automatic operation of booster pump shall be verified. The system operation shall not be affected during the continuous operation period of 7 days. If defects noted in the system during the seven days period the same shall be rectified by the contractor in a time bound manner without any additional cost to Employer. Leakage in the piping network, if any, noted during the commissioning shall also be attended by the contractor and rectified without any additional cost to Employer. The system shall be operated in manual mode also to confirm manual operation of the system. The commissioning of the system shall be carried out in close coordination with Employer. All equipments, tools, tackles, materials, personnel etc. required for the system commissioning shall be arranged by the Contractor at no extra cost to Employer.

C307 INSPECTION AND TESTING (SPRINKLER SYSTEM)

C307.1 Sprinklers

C307.1.1 It shall be factory tested for operation characteristics and chemical tests. Necessary test results shall be submitted before supply. The contractor shall establish the discharge of the sprinkler during the testing at site.

C307.2 Sprinkler alarm valve

C307.2.1 The pump shall start automatically and maintain pressure at the appropriate flow rate. The drain valve fitted above the alarm valve shall be opened and the time taken for the alarm gong to operate be noted. There shall not be a significant variation in the timing. The pressure at the "C" gauge of the alarm valve shall be noted at the full load condition of the pump and the value should match with that of the specification. The proper functions of the alarm gong associated with the alarm valve and its level of audibility shall be checked. An audibility level of 85 db above the background noise level is required. Necessary testing equipment shall be arranged by the contractor free of cost.

C307.2.2 While conducting the tests, the water flowing through the test valve shall be equivalent to the flow through one sprinkler. It should auto start the pumps and activate the alarm motor and gong. When the test valve is closed, the water flowing through the test valve should stop.

C308 PORTABLE FIRE EXTINGUISHERS

C308.1 The portable fire extinguishers shall be provided as per IS 2190 with references made to NFPA 10 wherever applicable. However, additional fire extinguishers shall be provided as per requirement of State Fire Service department. All Fire Extinguishers shall be as per the latest applicable IS codes.

C308.2 Typical location for different type of fire extinguishers includes, but not limited to, the following:

- 6.0 KG, multi-purpose ABC dry chemical type fire extinguishers: All areas except electrical rooms, kitchen, generator rooms and fuel pump room. One ABC powder extinguishers of 6 Kgs. Capacity for every 8 cars at parking areas should also be provided.
- KG or higher capacity CO2 fire extinguisher: Electrical Rooms.
- Clean Agent Extinguishers: Server and Data storage area.
- One Mechanical Foam extinguishers of 9 litres capacity & one ABC powder extinguishers of 6 Kgs. Capacity should be provided near the transformer.
- One Mechanical foam extinguishers of 9 litres capacity and one ABC powder extinguishers of 6 Kgs. Capacity should be provided near the diesel generator.
- One CO2 extinguishers of 2 Kgs. Capacity should be provided inside each lift machine room.

- 9L foam extinguisher, Trolley Mounted extinguishers like 25 Kg ABC extinguisher, 50 L mechanical foam extinguisher are proposed in accordance with IS 2190 in every building.

C308.3 All the extinguishers suggested above should be with B.I.S. markings and should be located at an easily accessible position without obstructing the normal passage and maintained periodically.

C309 FIRE ALARM SYSTEM

C309.1 General

C309.1.1 Fire alarm system shall be designed so as to detect all type of fires at the earliest possible time and give warning at the fire alarm control panel, repeater Panel if proposed and also at the locations where fire has occurred, so that timely action can be taken to protect life and property.

C309.1.2 The Fire Alarm System shall be of type as mentioned in scope above for various buildings. The Fire alarm control panel and related devices used in the system shall conform to International Standards UL/ FM.

C309.1.3 The system shall incorporate a PA system at the main control panel with selectors switch and Hooter/Speaker. The Public address system with two way talk back units with push to talk speakers to be provided at every staircase/ exit points in each buildings. Necessary console & amplifier with micro phone to be provided at ground floor.

C309.1.4 Before commencing work, the contractor must submit data showing that the manufacturer / vendor has successfully installed fire alarm systems of the same scope, type and design as specified. The contractor must provide the services of a factory trained and certified representative or technician, experienced in the installation and operation, maintenance and service of the type of system provided. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the Employer's personnel in the system operation, maintenance and programming.

C309.2 Standards and Codes

C309.2.1 The System shall meet the following design Standards as required by the law of the country. If no specific local laws are available National Fire Protection Association (NFPA) - USA shall be followed.

No. 72 National Fire Alarm Code

BS 5839 & Local Fire Code

The following IS shall apply to this Section:-

IS 2175:1988	Specification for heat sensitive fire detectors for use in automatic fire alarm system (Second revision)
IS 2189:1999	Code of Practice for Selection, Installation and Maintenance of Automatic Fire Detection and Alarm System (Third revision)
IS 11360-1985	Specification for smoke detectors for use in automatic electrical fire alarm system

Underwriters' Laboratories, Inc. (UL) Appropriate "UL" equipment standards:

- (a) UL 268 - Smoke Detectors for Fire Protective Signaling Systems
- (b) UL 864 - Control Units for Fire Protective Signaling Systems 9th Edition Listed
- (c) UL 268A - Smoke Detectors for Duct Applications
- (d) UL 521 - Heat Detectors for Fire Protective Signaling Systems
- (e) UL 464 - Audible Signaling Appliances
- (f) UL 38- Manually Actuated Signaling Boxes
- (g) UL 346 - Water flow Indicators for Fire Protective Signaling Systems
- (h) UL 1971 - Visual Notification Appliances

C310 PRODUCTS

C310.1 Equipment and Material, General

C310.1.1 All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

C310.1.2 All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

C310.1.3 All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

C310.1.4 **Fire alarm Control Panel:** The FACP shall be of microprocessor-based design having the required number of outgoing loops to connect addressable type detectors and devices. One loop must be capable of including a minimum of 150 devices. The main FACP should be suitable to accommodate required number of devices having 20% Loop cards as spare for detectors & devices as well. The panel shall have built in maintenance free battery, charger and automatic change over from mains to battery. Battery shall be capable of supporting the system for at least 24 hours of continuous normal operation. It shall have work station provision.

The panel shall be capable of performing the following functions:

- Each detector / device that is connected on the loop shall be identified by a unique address that shall be assigned to each device. This address shall indicate the individual device address as well as the address of the loop to which it is connected.
- Check the status of the system at definite preset intervals and give warning in case of system faults like open circuit, short circuit, dirty detector, removal of detector or any other faults.
- In case of fire the panel shall give audio as well as alphanumeric display.
- For switching off the AHU, Air conditioners or other equipment's in case of fire, provision for potential free contact shall be made.
- Shall be capable of getting connected to a PC for interfacing with any Building Management System and Public Addressing system.
- Shall have event log history of fault and alarm. (200 events minimum).
- Shall be capable of giving auto dial up information through telephone lines.
- Shall have port to connect a PC to do necessary programming, retrieval or information etc.
- Shall be capable of automatic compensation for loss of sensitivity of detectors due to Change in ambient condition, aging etc.
- Shall be capable of operating alarms/sirens/hooters and indications at remote location.

- C310.1.5 AFC and Lifts also shall be interfaced with fire alarm system. The provision for the same shall be considered in the FACP. Zone wise configuration with respect to area shall be designed for the same. The alarm shall be delay triggered (approx. 2 min programmed) from FACP to AFC system, Lifts with a facility to accept or reject in FACP to overcome spurious alarms. In the event of no response from Station controller to accept or reject alarm, command shall be forwarded to AFC system, Lifts after pre-programmed delay.
- C310.1.6 The enclosure of the panel shall be dust & vermin proof and shall be made of 1.6mm. Thick M.S. sheet duly painted/powder coated to have a neat finish.
- C310.2 Detectors
- C310.2.1 Detectors used shall be of analogue addressable type capable of giving exact location of fire. Detector shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits. In locations where heat is likely to rise rapidly such as kitchen, heat detectors shall be used. Detectors shall be of adequate sensitivity but it should not give false alarm due to cigarette smoke etc. Loss of sensitivity due to aging or dust should be automatically compensated by software in the control panel. Visual indication shall be provided by LED on the detector housing to indicate healthy operation, fault and alarm. There shall be provision for remote indication by LED for the above states whenever detector is mounted inside closed rooms or above false ceiling. Detector shall conform to UL/ FM standards. The detectors and the bases over which the detectors would be mounted shall be of same make and shall be compatible for interchange of detectors.
- C310.3 Manual Pull Station
- C310.3.1 Addressable manual pull station shall be of dual action type and must be compatible to be installed either flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds. The manual pull station shall be with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letter. They shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- C310.4 Wiring
- C310.4.1 Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits. The wiring shall be carried out by the contractor using FRLSZH PVC insulated armored copper cable and the same should be laid in GI conduit wherever the cable is exposed to the atmosphere. The contractor shall indicate the layout of detectors, MCPs, and configuration of wiring including color coding to be done. The design of the loop shall be such that not more than 90 % of the loop capacity of the panel is utilized with addressable devices connected in one loop.

- C310.4.2 The contractor shall submit detailed layout drawing to the Employer approval prior to execution.
- C310.5 Relay Module
- C310.5.1 These shall be of addressable type available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires. Monitor module shall be addressable type and shall derive power from the loop for its operation.
- C310.6 Isolator Module
- C310.6.1 Isolator modules shall be of addressable type and are to be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for every 20 devices. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- C310.7 Input Module
- C310.7.1 Input module shall be of addressable type and are to be provided to monitor contacts for such items as water-flow, tamper, and PIV switches connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each device and all physical devices shall require only one address on a signaling line circuit regardless of the number of circuits on an individual module. On activation of the third party device like flow switch the alarm must be indicated in the fire alarm panel and the hooters must be activated.
- C310.8 Sounder with Strobe
- C310.8.1 The sounder/strobe appliance as indicated on the drawings shall be a synchronized temporal horn with a synchronized strobe light with multiple candela taps to meet the intended application. The appliance shall be red or white as indicated on the drawings. The strobe light taps shall be adjustable for 15/75, 30/75, 75, and 110 candela. The appliance shall be red for wall mounted and white for ceiling mounted. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
- C310.9 Addressable type Rate of Rise type Heat Detector

- C310.9.1 Heat/thermal detectors shall be rated at 135 degrees fixed Fahrenheit temperature and 15 degrees Fahrenheit per minute rate of rise. The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement. The Heat Detector shall be Analogue Addressable detector with its own digital code and be able to give a single digitized output to the Fire Alarm Panel regarding its condition. The Detector shall employ the thermistor principle for heat sensing. It shall be able to communicate with the Fire Alarm Panel by the electrical pulses emitted from the Panel.
- C310.9.2 The construction of base shall be of poly carbonate or any approved proprietary flame retardant material. LEDs shall be provided to indicate locally alarm condition. The enclosure shall meet IP 22 protection grade.
- C310.9.3 It shall be able to operate in conditions with temperature ranging from 0° Centigrade to 50° Centigrade. Further, Relative Humidity (no Condensing type) up to 95 % shall not hamper its performance. The Voltage rating shall be from 17 V DC to 28 V DC, though the voltage may be changed depending upon the working voltages of a proprietary Fire Alarm Panel.
- C310.9.4 The Detector shall be UL/FM approved. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Bidder.
- C310.10 Addressable type Multi sense Detector
- C310.10.1 The smoke detector shall be analog addressable type, plug-in, two-wire, multi-sensor detector with both photoelectric and thermal inputs and must be compatible with Fire Alarm Control Panel and consisting of a dust resistant, field-cleanable photoelectric chamber, a solid state non-mechanical thermal sensor, and microprocessor based electronics with a low-profile plastic housing. The multi sense detector shall have an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity. The coverage per smoke detector shall be upto a minimum of 30 M2. This coverage area will reduce depending upon structural configurations or partitions etc.

- C310.10.2 Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
- C310.10.3 Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
- C310.10.4 Neither its performance shall be affected by air current up to 10m/s. The detector shall be suitably protected against dust accumulation / ingress and it shall be free from maintenance and functional test at intervals. All detectors shall be identical in construction design and characteristic to facilitate easy replacement. The detector housing shall be damage resistant made of polycarbonate or proprietary self-extinguishing material.
- C310.10.5 It shall be able to operate in conditions with temperature ranging from 0o Centigrade to 50o Centigrade. Further, Relative Humidity (non Condensing type) up to 95 % shall not hamper its performance. The Voltage rating shall be from 17 V DC to 28 V DC, though the voltage may be changed depending upon the working voltages of a proprietary Fire Alarm Panel. The Detector shall be UL/FM approved. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Bidder.
- C310.11 Repeater Panel
- C310.11.1 The Panel shall be controlled by a Micro-Processor that shall control all fire / fault / short signals. The micro-processor shall continually monitor each zone in the Panel for each signal, as well as the condition of the battery.
- C310.11.2 The Panel shall be provided with an LCD Display Unit of 2 lines of 40 characters that shall provide alpha numeric information on the fire / fault signal with zone number.
- C310.11.3 For accessing the LCD display a keypad operation shall be provided. The keypad shall have Help Menu and other functions controlled from either Function Keys or by a combination of keypad numbers. By using the Keypad one can scroll through the event list for at least a month.
- C310.11.4 The Processor shall be rugged with non-volatile memory. Due to voltage fluctuations and change from normal to standby current there shall be no variation in the software or programmed logic sequence. The Repeater Panel shall be provided with a Buzzer / Sounder to indicate Alarm, which shall generate automatically in case of an alarm in the area to which the Repeater Panel is connected / programmed.
- C310.12 Drawing & Manuals
- C310.12.1 The successful bidder shall prepare the following drawing and submit to the Employer for approval within 30 days of award of work.
- C310.12.2 Schematic diagram of the detectors, manual call points, hooters / sirens and interlocks with AHUs.

- C310.12.3 Floor wise Wiring diagram of the system indicating the location of detectors and other devices.
- C310.12.4 Work shall be started on receipt of approval of drawings, if any changes are required at the time of execution it shall be brought to the notice of Employer and got approved. On completion of work three nos. of prints and one no. of CD duly incorporating all the changes / modifications if any shall be submitted to the Employer.
- C310.13 Operating Manuals
- C310.13.1 The following manuals shall be supplied by the contractor on completion of the installation clearly specifying the:
- C310.13.2 Operating instructions, with a write up on the salient features of system offered.
- C310.13.3 Maintenance activities and its schedule.
- C310.13.4 Troubleshooting procedure.

C311 INSPECTION AND TESTING

- C311.1 Inspection
- C311.1.1 All materials shall be offered for inspection in cleaned condition, prior to erection. At no event, site fabricated work /material shall be installed in position without inspection and approval by Employer. The Contractor shall ensure that each stage of fabrication is carried out in compliance with the procedures specified in the IS or International standards as applicable and/or specified in this document.
- C311.1.2 The contractor shall conduct sample tests of all the materials supplied at reputed laboratories/agencies as directed by Client/Consultant at his own cost and test reports are to be submitted. Inspecting officials like Client/Consultant, Local Authorities shall have the right to access the premises of the work at any time with or without giving prior notice. All the formalities or procedures for conducting the inspections by the authorities as required by them shall be arranged by the contractor free of cost.
- C311.1.3 All testing shall be carried out in the presence of Client/Consultant/statutory authorities and test registers shall be maintained by the contractor. The contractor shall provide all material, tools, equipment, instruments, services and personnel required to perform the tests and remove debris resulting from cleaning and after testing free of cost.
- C311.1.4 The original test certificates of all tests conducted are to be forwarded to Client/Consultant. After conducting the tests, any defects found on materials, equipment, piping, etc. shall be got rectified / repaired / replaced by the Contractor without any extra cost.
- C311.2 Testing

- C311.2.1 The entire fire detection and alarm system shall be tested for continuity and performance as per IS-2189 code and NFPA 72. After installation, the visual inspection of all the detectors shall be made to make sure that they are properly installed. Each detector shall be inspected to ensure that it is properly mounted and connected. Heat detectors shall be tested to initiate an alarm by a heat source such as hair drier or a shielded heat lamp. After each heat test, the detectors shall be reset. Smoke detectors shall be tested to initiate an alarm at its installed location with smoke or other aerosol. All detectors found to have the sensibility outside the approved range shall not be used.
- C311.2.2 Detectors, control and indicating panels, sounders shall be tested at the manufacturer's factory and test certificate be furnished with the supply. Type test certificate to prove conformity to the relevant contract specifications shall be furnished with the supply, from recognized testing institutions or Govt. test bodies in India or abroad.
- C311.2.3 Following tests shall be conducted in the presence of the Client/Consultant and the test certificate shall be furnished with the record of tests.
- (1) Continuity test
Test for insulation resistance of the wiring work and the control and indicating panels.
 - (2) Test for system operation.
- C311.2.4 Tests for detectors shall be conducted using a test fire at normal floor level. The system operation for fault conditions shall be conducted by introducing faults such as open circuit, short circuit, removal of detector, open/short circuit in a sounder circuit etc. Tests relevant to loop isolators shall also be conducted to confirm that it functions as required.

C312 PUBLIC ADDRESS SYSTEM

C312.1 General

- (1) It will constitute a part of the master control panel and shall consist of
 - (a) Control console with microphone etc. (being integral part of Main Control Panel).
 - (b) Amplifier in Amplifier Rack etc.
 - (c) External speaker and connecting cable etc.
- C312.1.1 The speech will be fed from microphone, through the preamplifiers and amplifiers to combination speakers on various floors. The system shall include potential free contact/ control modules and accessories for interfacing with the Fire alarm system in the building.
- (1) The amplifier shall have solid state circuitry, properly tropicalized and capable of AC/DC operation and capable to drive the external speakers used for installation. It shall have provision of 3 channels namely (i) Alert, (ii) Evacuate and (iii) Speech.

- (2) There should be zone switches for selection where communication is to be made. Under normal condition, Auto/manual switch shall be in auto mode, in the event of fire in a particular floor, the speaker-cum-hooter connected to that floor will start producing an 'Alert Tone'. If it is necessary to warn other floors or all places there shall be zone switches as well as common switches through, which it can be done. If it is required to evacuate people from any of the areas Evacuate Switch is to be pressed to create Evacuate Tone. For accounting purposes, a speech switch is to be operated so that quality voice can be generated which will be optically indicated through LED. There shall be provision for adjustment of tone and volume in each case from the panel.
- (3) P.A system enclosure shall be fabricated sheet metal constitution and consisting the following switches and controls:
 - (a) One goose neck type moving coil/cardioid/hyper cardioid or equivalent microphone and one hand set to speak from any floors through manual call point telephone socket whenever necessary.
 - (b) Arrangement for speaking to each floor separately or all floors together.
 - (c) Provision for playing pre-recorded/taped instructions or otherwise as necessary through the speakers.
 - (d) Pre-amplifier, monitor loudspeaker and other accessories.
 - (e) Testing arrangements and provisions.
- (4) Amplifier rack shall have the following:
 - (a) Amplifier mounting rails.
 - (b) Lockable steel doors with proper ventilations slot for heat decapitations.
 - (c) Proper cable entry arrangements and terminal blocks.

C312.2 Design Requirement

C312.2.1 Speakers shall be connected in parallel and correctly phased. System should be designed for high impedance and impedance matching between microphones and pre-amplifier, amplifier and speakers on floor shall be done. Impedance of long length of cables also shall be considered. The system shall be properly earthed to avoid unwanted distortion in the system. System installation diagram giving details of cables routing, speaker installation, junction boxes etc. and circuit diagrams for P.A system amplifier etc. shall be given by the contractor.

C312.3 Power Supply

- C312.3.1 The Master Control Panel shall be provided with a complete charger unit, rectifier & distribution system. The charger shall be provided with auto change over system from normal to emergency supply in case of failure of normal power supply. The emergency power shall be derived from a battery, which shall be included in the offer. The unit shall rechargeable maintenance free dry have provision of protection against overload.
- C312.3.2 Only 230 V, 1 Ph., 50 Hz AC power supply shall be made available to the Master Control Panel from the nearest available power source. The cabling from the permanent supply source to the Master Control Panel and the cabling from Master Control Panel to the respective floors and to the individual sensing items external speaker-cum-hooter are to be included in the offer.
- C312.3.3 The Master Control Panels or any other panels requiring power supply for its operation shall be provided with “Power Supply Healthy “ON” “Indication” “Fuse Blown”, “Charge ON”, “Supply in EM Power” etc. indications.
- C312.3.4 The battery bank shall be such that all the equipment will work at its “Final voltage”.
- C312.3.5 The battery charging equipment shall incorporate automatic control features, which should match the output with the limits, specified by the battery manufacturer taking into consideration the quiescent load of the system.
- C312.3.6 Low battery voltage condition shall be monitored and indicated on MCP by visible and audible alarm.
- C312.3.7 Each battery of the secondary calls when charged by its normal charging arrangements for a period of 24 hours from the fully discharged condition shall then have sufficient power to supply quiescent load together with fault signal resulting from disconnection for a period of 24 hours. Thereafter it shall have enough supply to cope with additional load resulting in an alarm originating in all zones for 30 minutes. If utilized to sound emergency evacuation alarm it shall supply additional power for at least 10 minutes.
- C312.3.8 There shall be provision of protection against earth leakage current. All panels/equipments shall be effectively earthed whenever required to satisfy statutory & system requirements.

C313 SIGNAGE

- C313.1 Supply
- The scope of supply will include the following items:
- (a) Includes the supply of signage boards as per the BOQ
 - (b) Mounting arrangement for all the Signboards
- C313.2 Photo Luminescent Signage
- C313.2.1 All non-illuminated emergency exit directional / destination signage shall be made out of the photo luminescent sheeting which gets luminous in dark places even when the essential power supply has been cut off.
- C313.2.2 The sizes and colors of these signs shall be in accordance with the IMO symbols and installed as per the requirements of the Employer.

- C313.2.3 The photo luminescent sheeting shall be of cast film type with self-adhesive property. Photo luminescent sheet shall have minimum luminance property of 1 to 2 hours.
- C313.2.4 The Photo luminescent sheeting shall be made of materials which are non-toxic, non-radioactive and shall contain no Lead and Phosphorous and present no health or environment hazards. The photo luminescent signage shall be completely independent of electrical power or any source. These are to be fabricated and installed as per the directions of the Employer-.
- C313.3 Location
- C313.3.1 Details of location/ layout of signboards and text, logos pertaining to each signboards will be given to the contractor.
- C313.3.2 All work shall be installed square, plumb, straight, true to line or radius accurately fitted and located. Wall mounted multi information signs may be fixed along the direction of the flow on walls. All signs shall be vertically mounted and read horizontally
- C313.3.3 The mounting level or clearance of each sign shall be according to ceiling heights but specific for each floor level as directed by Employer.
- C313.3.4 Signboards shall be so placed that these do not obstruct sighting another signage and shall be placed according to the need as assessed by the Employer.
- C313.4 General
- C313.4.1 The signage shall have no sharp edges that are likely to cause injury during handling and maintenance. All screws used in assembly of fitting shall be engaged in nuts or tapped holes. Screw heads on the outside of fitting shall be counter sunk to ensure a smooth finish. Only ISI marked, wherever applicable, materials shall be used for the work. Letter, pictogram and arrows shall be precision made and free from imperfection. They shall be accurately cut aligned, clear and sharp. The contractor shall protect the Signage boards with protective application while installation.
- C313.5 Important Notes
- C313.5.1 The photo luminescent film shall be pasted on Aluminum composite panel of thickness 3mm size.
- C313.5.2 All signs shall be vertically mounted and read horizontally.
- C313.5.3 Signage shall be either fixed directly on Walls/ Columns using screws/double tape or hung from ceiling using proper suspender arrangement preferably of SS304 chain arrangement as approved by Employer.
- C313.5.4 All screws, nuts and bolts fasteners that are exposed should be cold forged and powder coated.
- C313.5.5 The suspender arrangement shall be made suitable to enable the signage to be fixed/ fitted on existing RCC roof / wall / truss work. The type of fixing shall be approved by Employer/Consultant prior to installation.
- C313.5.6 Color Coding used shall be as per International standards and directions of Employer. Wherever required ICAO/IMO standards should be followed.

- C313.5.7 The design of the sign boards should be of International standards with high quality finish.
- C313.5.8 All signboards should be maintenance friendly.
- C313.5.9 The detail model of all the sign boards with text, logo and location layout should be submitted and approved by Employer before installation.
- C313.5.10 All Clamps, suspenders, hooks and other accessories required for proper clamping of the sign boards on walls, columns, floor and ceiling shall be in the scope of contractor. No additional payment shall be made for this.

C313.6 Technical Data

(To be submitted along with the tender)

Booster (Terrace) pump

S. No.	Pump details
1.	Make
2.	Type
3.	Model
4.	Overall dimensions
5.	Weight (Kgs)
6.	Material
7.	Pump casing
8.	Impeller
9.	Shaft sleeve
10.	Base plate
11.	Operating speed (R.P.M.)
12.	Head (m)
13.	Efficiency
14.	Performance curves (whether enclosed with the tender) Yes/No
15.	Motor details
16.	Make
17.	Model
18.	HP
19.	RPM
20.	Weight

S. No.	Pump details
21.	Overall dimension

S. No.	Engine details
1.	Make
2.	Type
3.	Model
4.	Overall dimensions
5.	Weight (Kgs)
6.	Material
7.	Engine speed
8.	Number of cylinders / Cylinder arrangement
9.	Cycle
10.	Induction system
11.	Combustion system
12.	Compression ratio
13.	Efficiency
14.	Cubic capacity
15.	Sound level
16.	Fuel data
17.	Ratings
18.	Test conditions
19.	Cooling system
20.	Electrical system
21.	Exhaust system
22.	Induction system
23.	Lubrication system

C313.7 Loop isolators
Make
Model No.

Spacing of isolators

Operating voltage

Temp. Range

Size:

IP rating

Hooters

Make

Model No.

No. of tones

Sound output

IP rating

Size

C313.8 MCPs

Make

Model No.

Size:

IP rating

C313.9 Fire control panel

Make

Model No.

Maximum No. of programmable loops

Maximum No. of devices per panel

Maximum devices per loop

Maximum control cable length

Maximum resistance per loop

Length per loop

No. of slots for additional cards

Networking facilities

No. of auxiliary output for AHU shut off.

No. of repeater output

No. of hooters per loop

No. of isolators per loop

Operating voltage

- Operating current
- No. of display characters
- Support for bacnet and Modbus protocol.
- Size
- Weight
- C313.10 Battery (FCP)
 - Type of battery
 - Voltage V
 - Battery AH
 - Make of battery
 - Backup time of battery
 - Makes of following items
 - PVC insulated armoured copper FRLSZH cable Conduits
- C313.11 General Requirements
 - C313.11.1 All equipments and panels shall be rugged in design. It shall be reliable in design and should have long service life.
 - C313.11.2 Equipment shall be designed to operate continuously on a maximum ambient temperature of 45oC and the temperature rise shall be within the allowable limit. It shall also be so designed that it should work in local vibration and impacts, if arises at any time in the locality during use.
 - C313.11.3 The internal circuits shall be so designed that due to failure of any part/component or malfunction it should not give any false fire alarm signals at any time. It should instead may give rise to fault alarm signals only.
 - C313.11.4 There shall be no easily accessible normal controls, e.g. switches off – main/standby power supply etc. to the unauthorized person.
 - C313.11.5 All manual controls, indicators, switches etc. shall be clearly labeled to indicate their proper function/services. All manual controls shall be robust in construction positive in action and so located that no accidental operation can take place.
 - C313.11.6 All equipments and components shall be designed, manufactured and selected to work satisfactorily against deterioration due to temperature, humidity, corrosion etc. resulting from the atmospheric condition existing in the vicinity. The equipments and components shall be of first class good quality materials for its reliability. The cubicle type Master Control Panels shall be dust and vermin proof and to prevent ingress of moisture. Protective painting shall be provided after installation of the panels and equipments wherever required.
 - C313.11.7 The selection of the power supply unit and the cables shall be such that no appreciable voltage drop takes place. There shall be provision of protection against over load.

- C313.11.8 All the electrical/electronic components covered under this specification, shall conform to the following:
- (i) Components shall conform to the ISI specification or to BS specification where no IS specification exist.
 - (ii) Alarm indication lamps may have signals or double filaments to suit the requirement and it should be having longer life. The intensity of the indications shall be clearly visible from a distance at 10 meters in normal condition. LED may be used wherever it suits to have low power consumption.
 - (iii) Double lamps should be used to avoid confusion/inattention in case of one lamp blows off.
 - (iv) All frictional contact surfaces should be plated/flushed with double metals or equipments.
- C313.11.9 List of recommended spares for its normal and trouble free operation for at least 5 years shall be furnished separately with quoted price as on optional item.
- C313.11.10 Circuit Design - Latest design and technology shall be offered as accepted by the WEBEL or similar institution. All components shall be interchangeable in design. The equipment offered shall have "Self-diagnosis feature" of each circuit. The design of the circuits shall be such that any failure or malfunction in it shall activate automatic fault warning.
- C313.12 Conduit Wiring System
- C313.12.1 Conduit wiring shall be adopted in wall/floors/ceilings or similar other coverages. Wherever required chases are to be cut on wall/floor to suit the requirement of the fire protection system and made good in an approved manner. No extra cost will be paid on this account.
- C313.12.2 All conduits shall be of 19 mm or 25 mm dia made of PVC, ISI marked.
- C313.12.3 Necessary bends in the system including diversions shall be done by bending the pipes or by inserting suitable inspection type bends/elbows or similar fittings.
- C313.12.4 Generally 1100V grade 1.5 mm PVC insulated and sheathed copper cable shall be used conforming to IS 694 (Part II) with adequate number of cores required for wiring. However, the voltage drop in the system should be duly taken into consideration and higher size of cables may be selected wherever such necessity arises. Total number of cables shall be so taken in a conduit as to facilitate easy drawing of the cables.
- C313.12.5 For loop earthing G.I wires shall be used.
- C313.12.6 Panels and bigger items should be having cable glanding facility using double compression dust and moisture proof electro plated brass cable glands of approved make.
- C313.13 Cable Work

- C313.13.1 All heavy duty cables to be used for the purpose of connecting the fire protection system shall be PVC insulated and PVC sheathed copper conductor cables of armoured type conforming to IS 1554 (Part-I) 1964 of 650/1100V grade wherever used for indoor purpose. Cables concerned only with fire protection system are generally to be taken along the fire protection duct provided in the building. All cables after bringing to site must be got approved by the Employer before use. All relevant test certificates shall be submitted in support of the sound manufacturing of the cables for approval to the Employer. The requirement of the exact length of cables shall be determined by the successful tenderer after measurements at site.
- C313.13.2 Cables shall be laid in walls/ceilings/structures wherever concealed wiring is to be done but mainly the wiring run along the duct provided for the fire protection system shall be surface wiring. The cables shall be suitably supported @ 0.45 M for vertical run and @ 0.30 M for horizontal run in general, by means of M.S brackets and clamps or aluminium cleats fixed on M.S brackets. Bolts of suitable sizes are to be grouted on wall for fixing of the brackets. Cables to be laid underground shall be of armoured type conforming to IS 1554 (Part-I) 1964.
- C313.13.3 All the cables and wires should be tagged for proper identification. Wires should be identified by ferrules and cables by color bands at every 3 M distance.
- C313.14 List of Approved Make - Fire Hydrant System

1.	Motor	Siemens/ABB/Crompton Greaves/Kirloskar	Category -2
2.	Pump	Mather & Platt/KSB/Beacon/Grundfoss/Patterson/ Kirloskar/Flowmore	Category -2
3.	Engine	MAN/Cummins/Caterpillar/Kirloskar	Category -2
4.	MS / GI Pipe	Tata/Jindal/SAIL/Zenith	Category -2
5.	GI & MS fittings	Tube weld/Tube products/Punjab steel/Bharathforge	Category -2
6.	Valves	Inter valve/Audco/ Advance/ Leader/ Fouress	Category -2
7.	Foot valve	Kejriwal/Kartar/Normex	Category -2
8.	Pressure gauge	Fiebig/H.Guru	Category -3
9.	Pressure switch	Indfoss/Switzer/Schneider/Danfoss	Category -2
10.	Air release valve	Rapidcool/Anergy/Econosto/Emerald	Category -2
11.	Hydrant valve, Fire brigade	Minimax / Safex / Newage/Steelage(Minimax)/ Shah	Category -2

	point	bhogilal	
12.	Branch pipe	Newage/ Arihant/Shah Bhogilal/Steelage(Minimax)	Category -2
13.	RRL Hose	Newage/ Arihant/Shah Bhogilal/Steelage(Minimax)	Category -2
15.	Hose Reel	Newage/Shah Bhogilal/Steelage(Minimax)/Safex	Category -2
16.	Hose cabinet	Newage/ Zenith/Shah Bhogilal/Arihant	Category -3
17.	Hardware	TATA/Sundaram fasteners/GKW	Category -3
18.	Paint	Asian/ICI/Nerolac/Berger/Internation al /Akzonobel	Category -3
19.	Polymeric mix	IWL	Category -2
20.	Alarm valve	Tyco/Newage (ULlisted)	Category -2
21.	Sprinkler	Tyco/ Reliable/ Victaulic/Viking(UL listed)	Category -2
22.	Flexible hose for sprinkler drop	Tyco/ Newage/HD Fire	Category -2
23.	Flow switch	Tyco/Honeywell/Danfoss/Siemens/In dfoss	Category -2
24.	Fire Extinguisher	Minimax/safex/safeguard/lintex/bhar ath/cease fire/Supremex	Category -2

C313.15 List of Approved Make – Fire Alarm, PA System

1.	Fire alarm control panel / Detectors/ Modules/ MCP/ Sounder cum strobe/ Repeater panel	Siemens/ Simplex/ Notifier/ Honeywell/Advance Cooper/ Ravel/ Edwards (all UL/FM approved)	Category -2
2.	Graphical Software	Siemens/ Simplex/ Notifier /Laura soft/ Honeywell	Category -3
3.	Power supply unit	Uniteck/ Siemens/ Proteck /C System/ Notifier/ Honeywell/Ravel	Category-2
4.	FRLSZH Armoured Cable	Finolex/ Havells/ / RRKabel/RPG Cables/ Belden	Category -2
5.	PA cum talk back console	Agni/Ahuja/Bosch	Category -2
6.	Amplifier	Agni/Ahuja/Bosch	Category -2
7.	MS/PVC conduits	ISI marked	Category-3

C400 POTABLE WATER SUPPLY SYSTEM

C401 SYSTEM DESCRIPTION

C401.1 As part of the scope of work, the potable water shall be provided to meet the demand for various buildings and to the jetty and FIC for supply to ships. Potable water shall be pumped from the underground water tank to the elevated tank, as shown on the drawings and then distributed to various demand centers. The system will also have provision to directly pump the water from underground tanks to the ships.

C402 CODES AND STANDARDS

C402.1 Subject to the requirements of this document and other contract documents, all design work shall comply with the appropriate current standards issued by the bureau of Indian standards (bis), or if such a standard does not exist, then the appropriate current standard issued by the British standard institute (bsi). If appropriate standard from bis and bsi does not exist, then subject to notice by the Employer’s representative, an appropriate current standard from a reputable institution may be used.

C402.2 A list of codes and standards/specifications is provided below for reference only.

C402.3 BS/ BSEN

IS 8329	Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage [mtd 6: pig iron and cast iron]
IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage [mtd 6: pig iron and cast iron]
IS 12288	Code of practice for use and laying of ductile iron pipes
IS 13159 PT 1	Pipe flanges and flanged fittings part 1: dimensions
ISO 9000 SERIES	Quality assurance standards
ISO 2531	Ductile iron pipes, fittings, and accessories for pressure pipe-lines
ISO 4179	Ductile iron pipes for pressure and non-pressure pipelines - centrifugal cement mortar lining general requirements

ISO 6600	Ductile iron pipes centrifugal cement mortar lining (composition controls for freshly applied mortar)
ISO 7005	Metallic flanges
ISO 8179	Ductile iron pipes - external zinc coating
BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines. Requirements and test methods.
BS 4504 (PART 1)	Circular flanges for pipes, valves, and fittings
BS EN 1092	Flanges and their joints, circular flanges and accessories
BS 2494	Elastomeric seals for joints in pipe work and pipelines. General technical specification
ISO 4633/BS EN 681-1	Elastomeric seals. Material requirements for pipe joints seals used in water and drainage applications.
BS 3416.1991	Bitumen based coating for cold application.
BS 8010	Part 1 code of practice for pipelines on land
BS 6076, 1996	Polymeric film for used as a protective sleeving for buried iron pipes and fittings
BS 1706	Method for specifying electroplated coatings of zinc and cadmium on iron and steel
AWWA C151	Ductile iron pipe, centrifugally cast in metal moulds or sand-lined moulds, for water or other liquids
AWWA C110	Ductile iron and grey iron fittings. 3 inch through 48 inch for water and other liquids
AWWA C104	Cement mortar lining for ductile iron pipe and fittings for water

BS GN 545	Ductile iron pipes, fittings, accessories and joints for water pipe-lines.
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- C402.4 Pipe Material
- C402.4.1 All material including the accessories, supports etc., shall be resistant to corrosion and/or provided with anti-corrosive coating suitable for aggressive coastal conditions at the project site.
- C402.5 Ductile Iron (di) Pipes and Fittings
- C402.5.1 Where ductile iron piping is specified, it shall be class k9 pipe and comply with is 8329. Ductile iron fittings shall be class k9 fittings and comply with is 9523.
- C402.5.2 Where located above ground or in service ducts, pipework is to be fully flanged.
- C402.5.3 Where located below ground, the pipework is to be 'tyton' rubber ring jointed spigot / socket configuration.
- C402.6 Joints
- C402.6.1 Joint types shall be as shown on the drawings and meet the following requirements.
- C402.7 Flexible Joint (push-on joints)
- C402.7.1 Except where flanged joints are required, standard pipes and fittings for pipelines of ductile iron shall be supplied with push-in socket and spigot joints. The material of the joint rings use shall be in accordance with the requirement of bs 2494:1990.
- C402.7.2 Where pipes and fittings are not available with this type of joint, they shall be supplied with mechanical type flexible joints of the bolted gland type. Glands, bolts, and nuts for mechanical joint shall be of ductile iron having the same mechanical properties as the fittings.
- C402.8 Flange joint
- C402.8.1 Pn 20pressure rated flanges shall be flat faced and shall conform to the requirements of bs 4504 part 1 (or to iso 2531 or bs en 1092 or equivalent din standards which are compatible with bs 4504 part 1 for the same nominal diameters)
- C402.8.2 The flanges of all fittings including tees shall be integrally caste with the fitting.
- C402.8.3 "welded" means that the flanges shall be welded to the pipes at the point of manufacture under factory conditions with inspection agency certification.
- C402.8.4 All bolts to be supplied with flanges shall be of SS 316 to the approval of the Employer. Flanged joints shall be complete with all nuts, bolts, gaskets and two washers per bolt. Protection of all bolts, nuts, washers etc. And the joint, as a whole shall be covered with denso or equivalent paste, primer, mastic, tape and pvc or polyethylene outer wrapping.

C402.8.5 Gaskets for flanges shall be inside bolt circle type, with dimensions complying with BS 4865 Part I, and be manufactured from material complying with Bs En 1514, BS 2494:1990 type w listed in the directory of the water research centre, Uk or equivalent.

C402.8.6 The contractor shall be responsible for checking and ensuring that mating flanges are compatible in all cases, including where connections are required to pipe work and valves associated with pumping plant and inlet/outlet pipe work at service reservoirs or other structures.

C403 COATING AND LINING

C403.1 External coating

C403.1.1 Pipes and fittings shall be externally coated with metallic zinc and bitumen paint conforming to BS EN 545 or ISO 8179, which shall not contain any constituent soluble in water or any ingredient liable to leach in water after drying. The coating shall have good adherence to the pipe and fittings and not scale off. Thickness of the coating shall not be less than 70 microns.

C403.2 Internal lining

C403.2.1 Internal surface protection shall be cement mortar lining, pipes and fittings shall be internally lined with cement mortar using ordinary Portland cement conforming to BS12 or sulphate resisting cement confirming to BS 4072.

C403.2.2 The thickness of lining shall be as follows:

Pipe nominal Diameter (mm)	Thickness of lining (mm)	
	Nominal	Minimum
80 to 250	4	3
300 to 600	6	5
700 to 900	8	6
1000 to 1200	10	7

C403.2.3 Inside of socket shall be free of cement mortar lining and shall be coated with the material used for external coating. Internal lining shall be done in accordance with BS EN 545, ISO4179, AWWA C104, or equivalent.

C403.3 Mechanical properties

C403.3.1 The mechanical properties of pipes and fittings shall be as follows:

Minimum tensile strength	420 N/sq. mm
Minimum bending strength	590 N/sq. mm
Modulus of elasticity	14 to 18 x 10 ⁴ N/sq. mm

C403.4 Hydrostatic pressure test

C403.4.1 Ductile iron pipes and fittings shall have working pressure of 16 bars and shall be in accordance with ISO 2531 or with BS EN 545. The standard classes of pipes and fittings shall be as follows unless otherwise stated.

Socket & spigot pipes	k 9
Flanged pipes & all other fittings except tees	k 12
Tees and cross	k 14
Flanges	Pn 20

C403.4.2 Each pipe and fitting shall withstand the working hydrostatic test pressure given below:

Nominal diameter Mm	Hydrostatic test pressure (bar)	
	Pipe	Fitting
80 to 300	50	25
350 to 600	40	16
700 to 1000	32	10
1100 to 1200	25	10

C403.5 Fitting compatibility

C403.5.1 The contractor shall supply the fittings manufactured by the same manufacturer of pipes, using the same kind of material and compatible standards. The contractor shall also ensure the dimension compatibility of pipes, fittings and couplings.

C403.5.2 The pipes shall be galvanised mild steel welded (ERW) or (HFW) screwed and socketed conforming to the requirements of is: 1239.

C403.5.3 Gi pipe shall be provided at cope point connection and wherever less than 80mm in diameter.

C403.5.4 The pipes under this standard are designated by their nominal bore and are further classified as light, medium and heavy depending upon their wall thickness and shall be used as per required suitable pressure. Sockets of these pipes are designated by respective nominal bore of the pipe.

C403.5.5 Joints: the threads of all screwed and socket pipes shall conform to is: 554. The minimum length of thread in light pipes shall be 80 percent of that specified in is: 554. Each pipe shall be supplied with one socket.

C403.6 Valves and fittings

C403.6.1 All isolation valves, globe valve, puddle flange, etc., shall be of SS 316 construction, suitable for sea-shore condition at the site.

C403.6.2 Cam lock coupling shall be provided at the cope point for connecting hose pipe, which is coming from the vessel. Cam lock coupling shall be made of stainless steel 316.

C403.6.3 Expansion joints shall be located as shown on the drawings. Expansion joints shall be of the metallic bellows type, designed and supplied by a manufacturer specializing in such items, and shall comply with the american expansion joint manufacturer's standard or other approved standard. The installation of each bellows, including the positioning of adjacent anchors and guides, shall be strictly in accordance with the manufacturer's recommendations.

C403.6.4 Each bellows shall be designed in accordance with the following table:

Minimum pressure rating:	100 dn
Normal	550 kpa
Maximum (pressure relief valve setting)	700 kpa
Minimum axial compression (from as-installed position)	35 mm

C403.7 Pipe support

C403.7.1 contractor on the award of the work shall prepare detailed working drawings, showing the cross-sections longitudinal sections, details of fittings locations of isolating and control valves drain and air valves and all pipe supports. The contractor must keep in view the specific openings in buildings, jetty, approach and other structure through which pipes are designed to pass.

C403.7.2 The contractor shall design all pipe supports fitting in accordance with the relevant codes including is 1893 to adequately accommodate all loads and provide for all anti thrust devices to transfer loads at changes in direction of pipework. The contractor's attention is drawn to additional pipe supports required at services duct junction, branches in pipes and at cope points in particular. The contractor shall ensure that all supports material shall be resistant to corrosion and / or shall have anti-corrosive coatings suitable for coastal/ sea shore conditions at the project site.

C403.7.3 Piping shall be properly supported on suspended from on stands clamps hangers as specified and as required.

C403.7.4 Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. To permit free movement of common piping support shall be from a common hanger bar.

C403.7.5 Pipe hangers shall be provided at the following maximum spacing:

Pipe dia (mm)	Hanger rod dia (mm)	Spacing between Supports (m)
80 to 100	12	2.7
125 to 150	16	3.6
200 to 300	19	5.3

C403.7.6 All pipe work shall be carried out in a proper workman like manner causing minimum disturbance to the existing services buildings roads and structure. The entire piping work shall be organized in consultation with other agencies work so that area can be carried out in one stretch.

C403.7.7 Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.

C403.7.8 The contractor shall make sure that the clamps brackets saddles and hangers provided for pipe supports are adequate or as specified / approved by consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

C403.7.9 All pipes shall be accurately cut to the required sizes in accordance with relevant bis codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. All pipe work supports shall be provided with anti-corrosive coatings suitable to resist the corrosive conditions of the work site.

C403.8 Name plates and identifications

C403.8.1 All parts of the installation, which relate to operation and maintenance procedures, shall be provided with nameplates, tags or arrows, especially in enclosed areas, such as ceiling, shafts, and other places accessible for maintenance service.

C403.9 Submittal of data for approval

C403.9.1 The contractor shall submit to the GC complete information regarding details of materials and equipment involved, prior to any purchase or manufacturing operation. Any purchase or manufacturing operations carried out prior to obtaining such approval shall be at the contractor's sole responsibility.

C403.9.2 Information of equipment shall be separately submitted by listing all the details and with attached catalogue indicating at least the model, series, size and performance. Such data shall be in sufficient detail to enable the employer to identify the particular product and to form an opinion to its conformity to the specification.

C403.9.3 The contractor shall stamp the name of his company and sign all documents to be submitted for approval.

- C403.10 Approval of materials
- C403.10.1 Only new materials and equipment shall be incorporated in the works. All materials and equipment furnished by the contractor shall be subject to inspections and approval of the employer. The materials and equipment used for works shall be of approved makes. Any materials which, in the opinion of the employer, have lower quality than the approved makes shall promptly be removed from the job site.
- C403.10.2 Whenever requested by the employer, the contractor shall send materials to be tested by an independent institute selected by the employer.
- C403.11 Corrosion protection
- C403.11.1 The contractor shall ensure that all equipment, material, accessories and supports used for the project shall be resistant to corrosion and/or provided with anti-corrosive coating under the aggressive sea environment at the project site, as approved by the GC.
- C403.12 Shop drawings
- C403.12.1 As soon as the contract is awarded, the contractor shall prepare shop-drawings comprising complete details of items to be fabricated and works to be installed. These shop-drawings shall be submitted to the employer for approval.
- C403.12.2 The drawings shall be checked by the contractor for accuracy with regard to dimensions taken in the building(s) and shall closely follow manufacturer's recommendations. All submitted drawings shall be signed by the contractor and shall indicate the date of submission and the date(s) of revision(s).
- C403.12.3 In case shop-drawings require modifications for any reason, the contractor shall clearly identify the portion that was modified and shall indicate the running number of revision every time that a revised shop drawing is submitted.
- C403.12.4 The installation details shall be checked with the building works, the structure and other related trades to prevent conflicts that may cause delay of the project.
- C403.12.5 Size and scale of the shop-drawings shall be at least 1:100 scale except for enlarged scale details done for clarity, which shall be in conformity with international standards or as directed by the employer.
- C403.12.6 Where required by the employer, the contractor shall prepare additional drawings, diagrams, etc., which in opinion of the employer are considered necessary for a proper execution of the works.
- C403.12.7 The contractor shall not proceed with his work for a certain part or section, prior to the approval of the shop-drawings. Therefore, expense incurred because of modifications that have to be made as a result of lack of approved shop-drawings shall be borne by the contractor.
- C403.12.8 Approval of the shop-drawings by the employer shall not be construed as a complete check but will indicate only the general method of installation and its details are satisfactory.
- C403.12.9 The approval of the employer shall not release the contractor from his responsibility or his liability regarding the exact dimensions and further properties of the installations.

- C403.12.10 Shop-drawings submitted without sufficient detail shall be rejected and new submittal shall be required.
- C403.12.11 The contractor shall submit 3 blueprint copies of all shop-drawings for approval. If approved by the employer, one copy shall bear the employer's stamp indicating the date of approval and shall be returned to the contractor. After approval, 6 copies and a softcopy of blueprint are required, and additional copies may be requested by the employer as necessary.
- C403.13 Field testing
- C403.13.1 Test all equipment upon completion of installation to ensure that the equipment operates satisfactorily and to conform to contract documents.
- C403.13.2 Field testing shall be required for all equipment furnished, installed or connected by the contractor to ensure proper installation, setting, connection, and functioning in accordance with the plans, specifications and manufacturer's recommendations.
- C403.13.3 Testing shall be conducted in the presence of the employer and, when necessary, under the supervision of equipment manufacturers field employer.
- C403.13.4 All tests recommended by the equipment manufacturer whether specified in this specification or not, shall be included, unless specifically waived by the employer.
- C403.13.5 Testing shall include any additional tests required by the employer to determine the conditions of that equipment, material and system to meet requirements of the specifications.
- C403.13.6 The contractor shall maintain in triplicate, a written record of all tests showing date, personnel making test, equipment or material tested, tests performed and results. Three copies of test records shall be given to the employer within the following day.
- C403.13.7 The contractor shall notify the employer two weeks prior to commencement of any testing, except for metering.
- C403.13.8 Contractor shall be responsible for any damage to equipment or material due to improper test procedures or handling test apparatus and shall replace or restore any damaged equipment or material to original condition.
- C403.13.9 Safety devices such as rubber gloves and blankets, protective screens and barriers, danger signs, etc. Shall be provided by the contractor and shall be used to protect and warn adequately all personnel in the vicinity of the tests.
- C403.13.10 The contractor shall furnish all testing equipment and provide proper temporary power source for testing purposes when normal supply is not available at the time of testing.

- C403.14 Operation and maintenance instructions manual
- C403.14.1 The manual shall be prepared in hard cover binding in sets to be submitted to the employer on acceptance of the completed work.
- Section 1 – comprises submittal data of all equipment and materials that have been approved.
 - Section 2 – comprises catalogues, categorized in groups, complete with installation operations and the maintenance manuals from the manufacturers.
 - Section 3 – comprises filled out field test reports.
 - Section 4 – comprises spare parts list and recommended spare parts.
 - Section 5 – comprises maintenance and services schedule, and service and maintenance procedures for individual equipment listed daily, weekly, monthly, quarterly and yearly.
 - Section 6 – comprises system operations manual
- C403.14.2 A draft copy of the manual shall be submitted to the employer for approval first.
- C403.15 Works to completion
- C403.15.1 The contractor shall commission, clean down, and leave in full working order the works as specified.
- C403.15.2 As the installation proceeds the contractor shall prepare 'As Built Drawings'. It shall be sufficient to modify these contract drawings showing any revisions which have been made and submit the marked-up prints to the employer for approval.
- C403.15.3 The contractor shall deliver to the employer on completion of the works, manufacturer's literature, specifications, technical information and 'as built drawings' for all equipment installed.
- C403.16 Water Level Indicator
- C403.16.1 The contractor shall supply and install float less type switch probes in sprinkler and hydrant system tank to give low level alarm, low water level cut-out and earthing probe. Each probe shall be of correct length for particular application and tank location. The electrode shall be of polished stainless steel 20mm OD. Electrode holder shall be connected and wired to the building earth system of the building. The earthing probe shall be installed inside a 200mm dia PVC pipe acting as wave barrier. The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped down transformer shall be provided for each set of control probes and shall be installed inside centralized control cubical of pump room.

C403.17 Approved Manufacturer List

S. No.	Item		List of supplier(s)
	Description	Type	
1.	Pipes	Ductile iron	Electrosteel / kalahasti / jindal
2.	Valves	Ball valve	Av valves / bdk / flow serve / vmcl (voltech) / kbl
		Globe valve	Av valves / bdk / flow serve / vmcl (voltech) / kbl

C500 OXY-ACETYLENE PIPING DISTRIBUTION

C501 GENERAL

C501.1 This Section specifies the Scope of Work as design, manufacture, supply, installation, testing and commissioning of Oxy-acetylene gas pipework systems in Covered Dry Berth (CDB) area. The installation in general shall comply with bellow mentioned codes.

- NFPA-51 – Design and installation of Oxygen-Fuel Gas Systems for Welding, cutting and allied processes.
- IS:10811- Specification for Oxygen and Acetylene manifold regulators
- IS:15190- Acetylene pipelines- codes of practice

C502 STANDARDS

C502.1 Relevant Codes and Standards

ANSI B16.9	Factory –Made Wrought Steel Butt welding Fittings
ANSI B16.21	Nonmetallic Gaskets for Pipe Flanges
ANSI B31.1	Power Piping
ANSI B16.5	Pipe flanges and flanged fittings
ASTM A53	Standard specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
ASTM A 135	Standard specification for Electric resistance welded steel pipe.
ASTM A 795	Standard specification for black and hot dipped zinc coated (Galvanized) welded and seamless steel pipe for fire protection use.
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
BS 21/ BS EN 10226	2004 Pipes threads for tubes and fittings where pressure tight joints are made on the threads.
BS 143 & 1256	Malleable Cast Iron and Cast Copper Alloy Threaded Pipe Fittings
BS 476	Fire tests on Building Materials and Structures

IS 1239 & 3589	Steel tubes and tubulars suitable for screwing to BS 21/ BS EN 10226:2004 pipe threads.
BS 1560	1989 Circular flanges for pipes, valves and fittings (Class designated). Steel, cast iron and copper alloy flanges. Specification for steel flanges.
BS 1965	Butt welding pipe fittings for pressure purposes
BS 7874:1998	1990 Specification for elastomeric seals for joints in pipe work and pipelines.
BS 2633	1987 Specification for Class-I are welding of ferritic steel pipe work for carrying fluids.
BS 2971	1991 Specification for Class-II is welding of carbon steel pipe work for carrying fluids.
BS 3601	1987 Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes
BS 3974	Pipe Supports
BS EN 1092-1	Circular Flanges for Pipes, Valves and Fittings (PN designated)
BS EN 1514-1	Dimension of Gaskets for Flanges to BS EN 1092-1
BS CP 2010	Codes of Practice for Pipelines
IS: 817: Part 1	Approval Testing of Welders for Fusion Welding: steels.
BS EN 499 1995	Welding consumables. Covered electrodes for manual metal are welding of non-alloy and fine grain steels. Classification.
BS EN 970	1997 Non-destructive examination of fusion welds. Visual examination.
BS EN 1092-2	1997 Flanges and their joints. Circular flanges for pipes, valves fittings and accessories, PN

	designated. Cast iron flanges.
BS EN ISO 1461	1999 Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods.
ISO 7483	1991 Dimensions of gaskets for use with flanges to ISO 7005.

C503 MATERIAL AND SPECIFICATIONS

C503.1 Piping

C503.1.1 Oxy-Acetylene distribution piping and pipe fittings must be seamless Schedule 40S ASTM Grade 316 stainless steel. Copper alloys containing less than 65 percent copper may be used in connection with valves, regulators, gages, and other equipment used with acetylene. Stainless Steel 316L pipes properties and dimensions shall conform to EN 10312, series 2 and should be manufactured using Austenitic Stainless Steel material AISI 316L or EN 1.4404. Pipes supplied shall have a smooth outer surface, with external weld bead removed. Pipes to be supplied with ends capped to prevent ingress of deleterious material.

C503.2 Pipe Fittings

C503.2.1 Stainless Steel 316L ANSI/ASME B36.19 stainless steel weld type fittings with press ends shall be made from solution-treated molybdenum-steel AISI 316L in accordance with EN 10088 and preferably carry third party approvals such as DVGW. The fittings should have more than one-point press option. The pipes shall be available in diameters from 15 mm to 100 mm. The sealant EPDM 'O' ring in the fitting shall be in black color with reduced section to detect leakages, when not pressed in low pressures. The EPDM 'O' ring should withstand temperatures upto 110 Degree Celsius. The press fittings should be compatible to be used with SS316L pipes manufactured to EN 10312 Series 2 with material AISI 316L or EN 1.4404 and be capable of withstanding pressures upto 16 bar.

C503.3 Installation

(a) Acetylene pipes.

- (i) Pipes shall be of stainless steel. All pipes shall be seamless. Piping and accessories shall have a 300-bar certificate.
- (ii) Copper or copper alloys containing more than 65% of copper shall not be used in connection with acetylene.

- (iii) In central plants where two or more cylinders of acetylene are connected to a manifold, the supply pipes between the cylinders and the manifold shall be fitted with non-return valves that comply with relevant standards.
- (b) Oxygen pipes.
 - (i) Pipes shall be of stainless steel. All pipes shall be seamless. Piping and accessories shall have a 300-bar certificate.
 - (ii) In central plants where two or more cylinders of oxygen are connected to a manifold, the supply pipes between the cylinders and the manifold shall be fitted with non-return valves that comply with relevant standards.
- (c) Safety valves and similar devices.
 - (i) Safety valves and similar devices fitted in a gas cylinder central shall have a vent point on the open deck. The vent point shall be in a safe place at a height of minimum 3 metres above deck. The location of the vent point shall be marked.
- (d) The installation of piping system should be done as follows:
 - (i) Acetylene distribution piping and pipe fittings must be seamless steel. Copper alloys containing less than 65 percent copper may be used in connection with valves, regulators, gages, and other equipment used with acetylene.
 - (ii) Oxygen distribution piping and pipe fittings must be seamless steel or copper.
 - (iii) When more than two cylinders are connected to a manifold, the supply pipe between each cylinder and manifold shall be fitted with a non-return valve.
 - (iv) Except for the cylinder manifolds, acetylene is not to be piped at a pressure in excess of 100 kPa (14.7 psi).
 - (v) Pipe joints on the low pressure side of the regulators shall be welded.
 - (vi) Branch lines shall not run through unventilated spaces or accommodation spaces.
 - (vii) Relief valves or rupture discs shall be installed as relief devices in the piping system if the maximum design pressure of the piping system can be exceeded. The relief device set pressure shall not exceed the maximum design pressure of the piping system. Relief devices shall discharge to a location in the weather at least 3 m (10 ft) from sources of ignition or openings to spaces or tanks.

- (viii) Outlet stations are to be provided with suitable protective devices which will prevent the back flow of gas into the supply lines and prevent the passage of flame into the supply lines.
- (ix) Shutoff valves shall be fitted at each outlet.
- (x) Manufacturer approved press tool and jaw type should be used.
- (xi) SS316 L pipes should be cut using circular tube cutter and end should be square without any sharp edges.
- (xii) De-burring tool should be used after cutting to de-burr.
- (xiii) Fittings should be visibly checked before inserting pipe to check presence of foreign particle and integrity.
- (xiv) EPDM ring should be visibly checked for correct fit and integrity.
- (xv) SS316L pipes should be inserted completely up to the tube stop.
- (xvi) Manufacturers recommendations should be followed on pipe work support, distance between two press fit fittings and pipe work clearances.

C504 PRESSURE REGULATING VALVE

C504.1 Material of Construction

- (a) Body : Die Cast Aluminium
- (b) Working Parts : Aluminium
- (c) Disc : Synthetic rubber vulcanized to aluminium
- (d) End Details : Flanged as per ANSI ASA.150#

C505 GAS STRAINER

C505.1 Material of Construction

- (a) Body : Die cast aluminium
- (b) Filter Element : Polypropylene
- (c) Mesh Size : 50 Micron

C505.2 Pressure Gauge

- (a) Type : Diaphragm Type
- (b) Material of Construction
- (c) Case : S.S. 304
- (d) Block & Movement
 - (i) Material : S.S. 304

- (ii) Bourdon Material : S.S. 316
- (iii) Accuracy : $\pm 1\%$ of FS
- (iv) ORP : 130%
- (v) Gasket : Neoprene
- (vi) Range : 0-600 mbar, 0-1000 mbar
- (vii) Mounting : Direct with Bottom Entry
- (viii) Glass : Plain

C505.3 Fire Safe Ball Valve

- (a) Model : Fire Safe Series
- (b) Type : Regular Bore
- (c) Design : Two / Single piece design
- (d) Material of Construction
- (e) Body & Body Stainless steel as per ASTM
- (f) Connector : A.216 Gr. WCB Stainless Steel as per ASTM
- (g) Ball : A.351 Gr. CF8M
- (h) Seat : PTFE
- (i) Body Seal & Gland
- (j) Packing : Graphite
- (k) Stem Seal : 25% glass filled PTFE

C505.4 Gas Flow Meter

- (a) Type : Turbine, Mechanical Register
- (b) Material of Construction
- (c) Body : ASTM A.216 WCB
- (d) Rotor : Polyacetal Stainless Steel / Aluminium /
- (e) Other wetted part : Polyacetal
- (f) Accuracy : $\pm 2\%$

C505.5 Pressure Relief Valve

- (a) Body : Aluminium die cast
- (b) Diaphragm : Per-bunan
- (c) Seat : Aluminium

- (d) Spindle : Stainless Steel (S.S.304)
- C505.6 Flame Arrestor
- (a) Type : End of line mounting
- (b) Body : Cast Steel
- (c) Flame Bank : Stainless Steel (S.S.304)
- (d) Gasket : CAF
- (e) End Connection : Flanged end to ASA.150#
- C505.7 Motorized Ball Valve
- (a) Type : On-Off
- (b) Material of Construction
- (c) Body : ASTM A.216 Gr.WCB
- (d) Ball : S.S.316
- (e) Seat : PTFE
- (f) Design : Fire Safe
- (g) End Details : Flanged End to ASA.150#
- (h) Actuator Details
- (i) Electrical Supply : 230V, 50Hz, AC
- (j) Manual Operation : As required
- (k) Operating Time : 20-30 Sec.
- (l) Torque : As per manufacturer standard
- C505.8 Piping Ancillaries
- C505.8.1 This Section specifies the manufacture and installation requirements for gate valves, check valves, butterfly valves, motorized valves, gauge cocks, pressure reducing valves, ball float valves, safety and pressure relief valves, pressure gauges, pipe sleeves, expansion loops, expansion joints, pipe anchors, gaskets.
- C505.9 Relevant Codes and Standards
- BS 21/ BS EN 10226:2004: Pipe Threads for Tubes and Fittings where Pressure-Tight Joints are made on the Threads (Metric Dimensions)
- BS 1010: Draw off Taps and Stop valves for Water Services (Screw down Pattern)
- BS 1212: Float Operated Valves (Excluding Floats)
- BS 2456: Floats (Plastics) for Floated Operated Valves for Cold Water Services

BS EN 1171:2002:	Cast Iron Gate Valves / Sluice valve
BS 5152:	Cast Iron Globe and Globe Stop and Check Valves for General Purposes
BS 5154/ BS EN 12288:2003:	Copper Alloy Globe, Globe Stop and Check, Check and Gate Valves
BS 5155:	Butterfly Valves
BS 2879:	Draining Traps (Screw Down Pattern)
BS EN 1092-1:	Circular Flanges for Pipes, Valves and Fittings (PN Designated)
BS 5163:	Predominantly Key – Operated Cast Iron Gate Valves for Water Work Purposes.
BS EN 1982:	Copper and Copper alloy ingots and casting.
API-594:	Double Plate Check Valve

C505.10 Flashback Arrestor

C505.10.1 It is equipment which quenches a flame front (flashback or decomposition). It shall be suitable for flame, which may occur due to deflagration and/or detonation. Its design and application shall be such that it shall withstand and be effective in stopping a flame coming from either one or both directions.

C505.10.2 Flashback arrestors and non-return devices or a combination of both shall protect all acetylene gas pipeline system. For prevention of entry of air or oxygen these shall be fitted as near as practicable to any outlet point,

C505.10.3 The following locations shall be installed with flashback arrestors at:

- (a) The outlet of the source of acetylene gas such as a generation plant or discharge manifold rack;
- (b) The entrance and exit of gasholders, if installed, within the acetylene gas conveying systems;
- (c) The exit of each booster, if any installed on the acetylene gas pipeline;
- (d) Branch point from main header to shop subhead and
- (e) The entry to each consuming unit.

C505.11 Workstations

C505.11.1 An outlet station is a bracket with stop valves, regulators, manometer, and non-return devices for acetylene and oxygen located in a cabinet or otherwise satisfactorily protected.

C505.11.2 Outlet stations shall be located in a well-ventilated place and in such a way as to be protected against mechanical load.

C505.11.3 The stop valves of outlet stations shall be closed when the system is not in use.

C505.12 Valves and measuring devices

- C505.12.1 Valves shall be provided on acetylene gas pipework for isolation of pipe sections and equipment, control of pressure and flow, venting, draining, pressure relief, etc. They shall be suitable for service conditions in all respects and material and located suitably considering ease of commissioning, decommissioning, operation and maintenance.
- C505.13 The valves provided shall include but not limited to the following:
- (a) Stop valves shall be provided as follows:
 - (i) On all pipelines both at sources and consumers,
 - (ii) In the branch pipes to each consumer both at the point of branching and at entry to each consumer shop,
 - (iii) On long straight pipework without branch lines, at an interval of 400 to 500 m, for sectionalizing,
 - (iv) For purging of acetylene pipelines and for draining of test fluid/condensate, and
 - (v) For pressure gauges.
 - (b) Isolating and bypass valves for flowmeters, filters, etc.
 - (c) Non return valves on all pipelines requiring unidirectional flow.
 - (d) Pressure regulating valves together with isolation and relief valves for all pressure reducing installations.
 - (e) Manual drain valves at low points and manual vent valves at all high points of pipe work.
- C505.14 Globe Valves
- C505.14.1 Globe valves generally shall be used on service pipework as specified.
- C505.14.2 Globe valves up to and including 50 mm nominal diameter shall be generally rated, manufactured and tested to BS 5154/ BS EN 12288:2003. Valves over 50 mm nominal diameter shall be to BS 5152/ BS EN 13789:2002. Valves shall be of the same nominal bore as the pipework in which they are installed.
- C505.14.3 Globe valves when used for circuit regulation shall have characterized plug discs. The discs shall be free to rotate, readily removable from the valve stem and renewable. Discs may be manufactured using proprietary composition type materials if approved.
- C505.14.4 Valves shall have packed stuffing boxes or alternatively shall be fitted with 'O' rings.
- C505.14.5 Valves up to and including 50mm nominal bore shall have BS 21/ BS EN 10226:2004 taper screwed ends, valves of 65 mm nominal bore and larger shall have BS EN 1092-1:3.1 flanged connections.
- C505.14.6 Regulating valves shall be fitted with a lockable indicator on the spindle to show the proportional opening.
- C505.15 Gate Valves

- C505.15.1 Gate valves generally shall be used on service pipe work, and shall be fitted as necessary. Valves shall be rated, designed and tested in accordance with BS 5154/ BS EN 12288:2003 for bronze valves and BS EN 1171:2002 / BS 5163 for those of cast iron manufacture. Valves shall be of non-rising stems and same size as the nominal bore of pipeline in which they are installed.
- C505.15.2 Bronze bodied valves shall be cast to BS 1400/ BS EN 1982. Valves with cast iron bodies shall be made to BS 1452/ BS EN 1561. The bodies shall be of an even thickness throughout, clean and free from scale flaws. Valves up to and including 50 mm nominal bore shall be bronze bodied, 65 mm nominal bore and larger may be bronze or cast iron.
- C505.15.3 Valve wedges may be of cast iron, bronze, nickel alloy or stainless steel. Cast iron wedges shall have bronze trim and seating. Slide valves shall be fitted with stainless steel springs. Wedges shall be renewable and free to rotate on the valve spindle.
- C505.15.4 Valves shall have packed stuffing boxes, or alternatively shall be fitted with 'O' rings.
- C505.15.5 Gate valves shall be tested as follows at the place of manufacture prior to dispatch to Site: -
- (a) Body Test**
- With both ends closed and the gate in the open position, the body shall be tested to one and a half times the maximum working pressure for a minimum of 30 minutes. There shall be no visible leakage.
- (b) Seat Test**
- With one end open to the atmosphere and the gate in the closed position, the seat of the valve shall be tested for tightness when one and a half times the maximum working pressure is applied to the other end of the valve for a minimum of 30 minutes. The seat test shall be carried out in both directions. There shall be no visible leakage past the gate.
- C505.16 Check Valves
- C505.16.1 Check Valves shall be installed in the specified locations. Care shall be taken to ensure that the valves provided are suitable for installation in the plant required. In general, double plate check valve conforming to API 594 Specifications shall be used unless otherwise specified. Disc shall be centre guided and operated with stainless steel spring and trim to ensure smooth, positive opening and closing of valves with minimal pressure drop. Check valves shall not be installed in vertical pipes with downward flow.
- C505.16.2 Check valves generally shall be of 16 bar nominal pressure rating (working pressure).

- C505.16.3 Bronze bodied valves shall be cast to BS 1400 / BS EN 1982. Valves with cast iron bodies shall be made to BS 1452 / BS EN 1561. The bodies shall be of an even thickness throughout, clean and free from scale and flaws. Valves up to and including 50 mm nominal bore shall be of bronze. Valves on 65 mm nominal bore and larger shall be of cast iron.
- C505.16.4 Check valves shall be tested as follows at the place of manufacture prior to dispatch to Site: -
- (a) Body Test**
- With both ends closed the body shall be tested to one and a half times the maximum working pressure for a minimum of 30 minutes. The pressure shall be applied to the inlet side of the body. There shall be no visible leakage.
- (b) Seat Test**
- With the inlet open to atmosphere, the seat of the valve shall be tested for tightness when one and a half times the maximum working pressure is applied to the outlet end of the valve for a minimum of 30 minutes. There shall be no visible leakage.
- C505.16.5 Inverted mounting of valves shall not be permitted without prior Approval by the Employer.
- C505.16.6 Valves of identical make, size, type and duty shall be fully interchangeable.
- C505.17 Safety and Pressure Relief valves
- C505.17.1 A safety relief valve shall be set so as to open and relieve the gas when the pressure in the pipework being protected by it exceeds 1.1 times the maximum working pressure. The safety relief valve shall be capable of a flow rate equal to or greater than the maximum flow in the pipeline.
- C505.17.2 Safety relief valves of reliable design and performance, which are able to keep pressure within 10 percent above the maximum working pressure, shall be selected. No isolation valve should be provided at the safety valve line.
- C505.17.3 Valves shall be constructed in accordance with BS 759 and shall have stainless steel trims.
- C505.17.4 The valve size shall be carefully selected to match the plant and to give the appropriate degree of protection.
- C505.17.5 Safety valves shall be of the totally enclosed spring loaded type with padlock.
- C505.17.6 Relief valves shall be mounted with the centre line of the valve spindle in a vertical position to ensure that the valve reseats properly after operation.
- C505.17.7 Relief pipe connections shall be of equal bore to the vessel connection or as specified.
- C505.17.8 Relief pipes from valves shall be run in full bore tubing of the same quality as the service vessel or pipeline with which the valve is associated. The piping shall be carried clear of any insulation and arranged to discharge to a visible and safe position Approved by the Employer.

- C505.18 Pressure Gauges
- C505.18.1 Pressure gauges, conforming to relevant BS specification shall have black enamel iron casing of 100 / 150 mm in diameter, threaded chromium-plated brass ring with heavy glass, bronze spring tube, red pointer, precision movement and micrometer adjustment. Provide pulsation dampeners, steel pipe fittings and shut off cocks of needle point globe type, all brass, for 10.35 bar positive or those negative working pressure as required for the installation. Where gauges are installed on thermally insulated surfaces, stand-off mounting devices shall be provided.
- C505.19 Pipe Sleeves
- C505.19.1 Provide mild steel pipe sleeves where pipes pass through walls, floors or as indicated on the Drawings. Sleeves shall be of sufficient size to allow free movement of pipes. The space between pipe sleeves and the pipe or insulation shall be completely caulked with a soft, non-setting waterproof mastic compound to give an air tight seal.
- C505.19.2 Pipe shall be free to move in pipe sleeves which shall not be used as pipe supports.
- C505.19.3 Where pipes pass through fire walls and floor slabs, a metal fire stop in the form of a 6 mm thick flange shall be welded around the pipe and located in the centre of the slab/wall thickness. The flange shall be same diameter as the internal bore of the pipe sleeve.
- C505.20 Expansion Joints
- C505.20.1 Provide expansion joint (axial, hinged and gimbal type) wherever expansion loops or change in direction of pipework expansion and contraction of pipework where otherwise expansion and contraction of pipework is not feasible. It shall conform to relevant BS or equivalent standard.
- C505.20.2 Provide expansion joint at all building expansion joints, and wherever else expansion joints are specified, additional allowance shall be made by the provision of stainless steel articulated bellows type expansion compensators complete with all necessary guides as recommended by the manufacturer to give a working life of not less than 25 years. Each compensator shall maintain at least the same cross-sectional area as adjoining pipework for its entire length.
- C505.20.3 Ensure the expansion joints are adequately tied, anchored or removed to avoid damage to the bellows during sectional testing.
- C505.20.4 Expansion joints shall have stainless steel membrane and carbon steel fittings.
- C505.20.5 Design working pressure shall be as specified on the Equipment Schedules and/or Drawings while the testing pressure shall be at least twice of the working pressure. Designed life to be 12,000 (minimum) complete cycles of movement over the entire working range without failure.
- C505.20.6 Joint shall be securely held by guides on both sides.

- C505.21 Pipe Anchors
- C505.21.1 Provide anchor points constructed from carbon steel bolted to the building structure.
- C505.21.2 Anchors shall be positioned in association with pipework change in direction, expansion joints and loops so as to absorb stresses due to pipework expansion and internal pressures by transmission of such forces to the structure at appropriate points.
- C505.21.3 Anchors shall be constructed to withstand the highest thrust during piping hydraulic pressure testing.
- C505.21.4 All details, calculations and sizes of anchors shall be submitted for Approval prior to installation.
- C505.22 Drain Points
- C505.22.1 Provisions shall be made to drain accumulated condensate or testing fluid from acetylene pipelines. To ensure condensate drainage and liquid drainage, pipelines shall be laid with a gradient of about 1 mm/ m run towards the drainage points. Drainage points shall be provided at the lowest points of acetylene gas pipe work and special provisions shall be made in its design to prevent entry of air into the acetylene line and to prevent freezing of any seal liquid used. The size of the drain pipelines shall be such that the entire pipeline between sectionalizing valves can be drained within the desired time period, which shall be not more than 30 min.
- C505.23 Installation General
- C505.23.1 Prior to the installation of acetylene and oxygen pipelines, piping as well as connections shall be thoroughly cleansed to remove all grease, oil and other combustible substances. No combustible or organic solvent may be used for this purpose. After the degreasing, pipelines and connections shall be blown clean with fat-free nitrogen, both prior to and after the installation.
- C505.23.2 Compressed air from an oil-lubricated compressor or oxygen shall not be used.
- C505.23.3 The installation shall be neat and tidy, with accurate spacing between pipes, valves and joints, whether running in straight routes or turning through bends.
- C505.23.4 Particular care shall be taken that all pipework is erected and secured truly parallel with the building structure, clear of obstructions, preserving headroom and keeping passageways clear and that all vertical drops are plumb.
- C505.23.5 No bends or curves in any pipe shall be made so as to diminish the passage or alter the internal diameter of the pipe.
- C505.23.6 All pipes shall be fitted clear of the floor to permit cleaning beneath the pipes. Where possible, a 125 mm clearance shall be provided between the underside of the pipe and the finished level of the floor and in no case shall the pipe be less than 100 mm clear of the floor.
- C505.23.7 Site welding shall be applied with pipe work unrestrained and each joint hydraulically tested at 1.5 times working pressure plus 350 kPa for 60 minutes without loss of pressure. Working pressure to be considered as 862 kPa.

- C505.23.8 All pipe runs when buried underground shall be tested and Approved before being covered.
- C505.23.9 Where it is not possible to install the pipework with setting out dimensions as shown on the Drawings, minor deviations will be allowed, subject to prior Approval.
- C505.23.10 Where pipes pass through walls and floors, steel pipe sleeves shall be provided to allow free axial movement of the pipes. Sleeves passing through walls shall be of sufficient length to fully enclose the pipe, from one side of the finished wall to the other side. Sleeves passing through floors shall protrude at least 50 mm above and below the finished floor and soffit to enclose the pipe.
- C505.23.11 Where pipes pass through water-containing chambers, puddle flanges of Approved design shall be provided.
- C505.23.12 All pipe installations shall be provided with removable sections to facilitate pipe-cleaning operations.
- C505.23.13 Pipework shall rest freely upon supports and be carefully aligned prior to final connection.
- C505.23.14 All pipes on straight runs shall be lined up with facilities for pipes to be rotated for the process of welding joints to avoid welding from the bottom as far as possible.
- C505.23.15 During storage, all pipes shall have end covers fitted to prevent the ingress of any unwanted particles or waste.
- C505.23.16 During installation, all open ends of pipes shall be blanked off with blank flanges or pipe caps. These shall be removed only immediately prior to connecting to adjacent sections. As soon as pipes have been installed, all open ends shall be covered to prevent entrance of materials that would obstruct the pipes. Covers shall be left in place until removal is necessary for completion of the installation.
- C505.23.17 The Employer reserves the right to reject any material deemed to be unsuitable for installation and such material shall be removed from the Site and be replaced with Approved material at no extra cost to the Employer.
- C505.23.18 Steel welded fittings shall be of the same weight as the piping with which they are to be used. Long radius welded elbows shall be used at changes in the direction of the pipework. Welded tees shall be used for branches of the same size as the main pipe.
- C505.23.19 Bellow expansion joints shall be provided for expansion and contraction in the pipework and also provided where the pipes cross construction expansion joints. The expansion joints shall be capable of absorbing axial and lateral movements. Confirmation shall be obtained from the proposed expansion joint manufacturer on the suitable choice of the proposed joints.
- C505.24 Cleaning Procedures
- C505.24.1 Precautions shall be taken to avoid introducing foreign matter such as welding beads and slag or dirt into the piping system.

- C505.24.2 Following fabrication and installation, all piping of 150 mm and smaller shall be cleaned by flushing with clean water, run to waste, until thoroughly free of all dirt, oil and cuttings. Generally, each size of pipe shall be flushed separately before being joined with larger size piping.
- C505.24.3 Piping of 200 mm and larger shall be cleaned by pulling through a steel brush for the entire length of each pipe size, followed by fiber brush or swabs. Brushes and swabs shall be slightly larger than the inside diameter of pipe being cleaned.
- C505.24.4 All cleaning operations shall be continuous throughout the piping system, except at joints required for final jointing of various sections of cleaned piping. After cleaning and until final joints are made, the end of sections of piping shall be tightly sealed off to prevent any dirt, water and other foreign matter from entering the pipes.
- C505.25 Supports General
- C505.25.1 Tender drawings indicate schematically the size and location of pipes. The Contractor on the award of the work shall prepare detailed drawings, showing the cross-sections longitudinal sections, details of fittings locations of isolating and control valves drain and air valves and all pipe supports. The Contractor must keep in view the specific openings in buildings, jetty, FIC bay and other structure through which pipes are designed to pass.
- C505.25.2 The Contractor shall be responsible for the primary and secondary supports for all pipes services.
- C505.25.3 All brackets, stays, frames, fixed and roller supports and hangers necessary to carry and support all pipes and valves shall be provided.
- C505.25.4 The Contractor shall prepare fabrication drawings for piped services and primary and secondary pipe support identifying all unistruts, brackets, columns, pipe clamps, hangers, pipe support attachments, anti-thrust devices, concrete pedestals, vibration isolators etc. not shown on the Drawings. Following preparations of fabrication drawings any subsequent additional primary pipe support and all secondary pipe support identified shall be fabricated and installed as required. The Contractor shall be deemed to have allowed for all required pipe support in accordance with the appropriate standards. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
- C505.25.5 Primary pipe support comprises brackets attached to unistruts cast in concrete and steel columns. The contractor shall coordinate with the civil contractor and provide their requirements for any inserts/unistruts etc to cast in concrete.
- C505.25.6 Secondary pipe support comprises pipe clamps securing pipes to the primary pipe support, hangers, pipe support attachments, hooks, anti-thrust devices, concrete pedestals etc. All metallic pipe support elements shall be grade 316L stainless steel.

- C505.25.7 All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fiber glass tissue, each layer laid in bitumen.
- C505.25.8 The Contractor shall also provide calculations for number of anti-thrust devices, expansion joints and their location to the Employer for approval.
- C505.25.9 Supports shall only be attached to structural framing members. Where supports are required between structural framing members, a suitable intermediate metal framing shall be provided.
- C505.25.10 Pipe route marker will be at every 100m for buried pipe as advised by the Employer.
- C505.25.11 The contractor shall take care to keep the minimum distance between the services as per as good practices and applicable codes/ standards.
- C505.25.12 Piping shall be supported independently from all equipment so that equipment is not stressed by the weight of the pipe or expansion.
- C505.25.13 Valves or other heavy items of pipework equipment shall be fitted as near as practicable to a point of support or fitted with their own supports.
- C505.25.14 Supports shall be located to ensure that pipework branches of fittings are not restrained by the support during expansion or contraction of the pipework service.
- C505.25.15 Contact of dissimilar materials shall be avoided. Steel piping shall have steel supporting member actually in contact with the pipe. Pipes shall be supported on either side of changes of direction and pipeline mounted equipment.
- C505.25.16 Vertical piping shall be guided or supported in the center of each riser with approved steel brackets to prevent swaying, sagging, vibration and resonance. Strain that causes lines to snake or buckle between supports or anchors shall be avoided.
- C505.25.17 Where piping is subject to a vertical movement due to thermal expansion of 3 mm or more, hangers shall be of variable spring design. Variation of hanger force during operation shall range between 85 % and 120 % of the actual load.
- C505.25.18 Pipes fixed to walls or floors both vertically and horizontally shall be supported by brackets fixed to walls or supported from the floor.
- C505.25.19 All pipes in ducts shall rest on rollers and chairs, or hangers and be suitably arranged and supported to allow for expansion and contraction.
- C505.25.20 Pipe work supports and hangers shall be generally to BS 3974: Part 1 & 2. Details of all supports, hangers and accessories shall be submitted for Approval before installation.
- C505.25.21 In general, all supports, hangers, anchors and fixing accessories shall be hot-dipped galvanized painted with specified anti-corrosive paint unless specified.
- C505.25.22 Design of the hangers shall be compatible with pipe or tubing to be supported.

C505.25.23 The supports shall be of sound construction and shall be adequate for the weight to be carried and shall permit free expansion and good appearance and also permit piping runs to be readily dismantled where appropriate.

C505.25.24 Support spacing. Unless otherwise specified, pipe supports shall be provided at intervals in accordance with the following table or as per calculations provided by the contractor whichever is lower:

C505.26 For Steel Pipes

Size of Pipe(mm)	Maximum Intervals for Vertical Runs (m)	Maximum Intervals for Horizontal Runs (m)
15	2.5	1.8
20-25	3.0	2.5
32	3.0	2.7
40-50	3.6	3.0
65-80	4.5	3.6
100	4.5	4
150 & above	5.5	4.5

Also for each length of pipe minimum 2 supports should be provided.

C505.27 Hanger Rods

C505.27.1 Hanger rods of steel threaded and fitted with two removable nuts at each end for positioning rod and hanger and locking each in place shall be provided.

C505.27.2 Unless otherwise specified, hanger rods shall be of the following sizes:-

Size of Pipe (mm)	Single Rod Dia (mm)	Double Rod Dia (mm)
15 to 50, inclusive	10	10
65 and 80	13	10
100 and 125	15	13
150	20	15
200, 250 and 300	22	20

- C505.27.3 Secure hangers from metallic inserts cast into concrete. When these inserts are not available, attachment by anchor bolts to be placed with fast setting high strength grout shall be used.
- C505.27.4 Hanger shall be placed close to the point of change of direction of a pipe in either a horizontal or vertical plane.
- C505.27.5 Supports and hangers for pipe shall be placed as close as possible to joints. When hangers or supports are not within 300 mm of a branch line fitting, additional hangers or supports shall be provided.
- C505.28 Welding
- C505.28.1 Preparation for welding shall comply with the following requirements
- C505.29 Welding of steel pipes
- C505.29.1 Steel piping shall be mill-beveled on both ends before welding, beveled to $37\frac{1}{2}^{\circ}$.
- C505.29.2 Weld spacing on all butt welds shall comply with the following table:

Nominal Pipe Wall Thickness	Spacing	Bevel Angle
6.35mm or less	3mm	$37\frac{1}{2}^{\circ}$
Over 6.35mm to 19.5mm	5mm	$37\frac{1}{2}^{\circ}$

- C505.29.3 Backing rings shall be used on all butt-welded joints.
- C505.29.4 Before starting any welding, all corrosion products and other foreign material from surfaces to be welded shall be removed by scraping, brushing, chipping and swabbing.
- C505.29.5 Welding process: Welding shall be carried out by either manual shielded metallic arc process or automatic submerged arc process using direct current. All pipeline welding shall conform to AWS D10.18 and in accordance with latest accepted practice applicable to the particular service. Welding procedure specifications shall be submitted for the Approval.
- C505.29.6 Welding operation: Electrodes, voltage, current, thickness and number of passes or beads, shall be as previously specified. After deposition, each layer of weld metal shall be cleaned to remove all slag and scale by wire brushing and grinding and chipped where necessary to prepare for deposition of the next layer. Welded reinforcement shall be not less than 1.6 mm nor more than 3.18 mm above the normal surface of sections being welded. Reinforcement shall be crowned at centre and tapered on each side of surfaces being jointed. Exposed surfaces of weld shall present workmanlike appearance and be free of depressions below surface of jointed members.
- C505.29.7 Weld metal shall be thoroughly fused with base metal at all sections of weld. Penetration of weld shall include unbeveled portion and extend to inside walls of pipe.
- C505.30 Inspection

- C505.30.1 All welds shall be inspected visually and non-destructively by the Employer. The Employer reserves the right to order at random the examination of 2 % of the number of the welded joints for ultrasonic test by an independent firm nominated and paid by the Contractor. Should any one of the above welds prove faulty in materials or workmanship, further test of welds will be ordered up to a total of 4 % of the welded joints. If the number of welds failing the tests within the above 4 %, it is sufficient to suggest that an operative is not consistent in standard, the Employer may order any number of that welds to be removed and rectified at no extra cost to the Employer.
- C505.30.2 Certification on the qualification of each welder in accordance with BS EN 287: Part 1 shall be submitted.
- C505.31 Commissioning and Testing
- C505.31.1 The piping system shall be subject to testing as per ASME B31.3.
- C505.31.2 Headers in the copes are to be blanked at the flange to the branch line supplying gas to the header prior to the testing. Drain and balance lines shall be isolated in such a way as to exclude their isolation valves.
- C505.31.3 Following hydrostatic testing, the test fluid can be drained, subject to the approval of the Employer, via drain points. The piping system must be allowed to dry under atmospheric conditions and then purged with compressed air.
- C505.31.4 Following commissioning, leakage from the piping system shall be measured using the method outlined in section 15.2 of IS 6206.
- C505.32 Operation
- C505.32.1 When not in use cope point connections should be covered using blank flanges or threaded end caps of approximate size.
- C505.33 Nameplates and Identifications
- C505.33.1 All parts of the installation, which relate to operation and maintenance procedures, shall be provided with nameplates, tags or arrows, especially in enclosed areas, such as ceiling, shafts, and other places accessible for maintenance service.
- C505.34 Submittal of Data for Approval
- C505.34.1 The Contractor shall submit to the Employer complete information regarding details of materials and equipment involved, prior to any purchase or manufacturing operation. Any purchase or manufacturing operations carried out prior to obtaining such approval shall be at the Contractor's sole responsibility.
- C505.34.2 Information of equipment shall be separately submitted by listing all the details and with attached catalogue indicating at least the model, series, size and performance. Such data shall be in sufficient detail to enable the Employer to identify the particular product and to form an opinion to its conformity to the Specification.
- C505.34.3 The Contractor shall stamp the name of his company and sign all documents to be submitted for approval.
- C505.35 Approval of Materials

- C505.35.1 Only new materials and equipment shall be incorporated in the Works. All materials and equipment furnished by the Contractor shall be subject to inspections and approval of the Employer. The materials and equipment used for Works shall be of approved makes. Any materials which, in the opinion of the Employer, have lower quality than the approved makes shall promptly be removed from the job site.
- C505.35.2 Whenever requested by the Employer, the Contractor shall send materials to be tested by an independent institute selected by the Employer.
- C505.35.3 Due care shall be taken by the contractor to ensure the material offered be worthy for coastal condition of the project.
- C505.36 Corrosion Protection
- C505.36.1 The contractor shall ensure that all equipment, material, accessories and supports used for the project shall be resistant to corrosion and/or provided with anti-corrosive coating under the aggressive sea environment at the project site, as approved by the Employer.
- C505.36.2 All struts, fasteners etc. to be grouted into the concrete shall be Stainless steel SS316L.
- C505.36.3 Contact of Dissimilar items shall be avoided. Appropriate coatings and gasket material shall be used to avoid the contact of dissimilar material
- C505.36.4 SS316L material may not require the protective coating. All other material shall be provided with the protective coating as given in the subsequent clauses. For further surface protection, refer clause B 1302 of Section 6B.
- C505.37 Shop Drawings
- C505.37.1 As soon as the Contract is awarded, the Contractor shall carry out design and prepare shop-drawings comprising complete details of items to be fabricated and works to be installed. These shop-drawings shall be submitted to the Employer for approval.
- C505.37.2 The drawings shall be checked by the Contractor for accuracy with regard to dimensions taken in the structures and shall closely follow manufacturer's recommendations. All submitted drawings shall be signed by the Contractor, and shall indicate the date of submission and the date(s) of revision(s).
- C505.37.3 In case shop-drawings require modifications for any reason, the Contractor shall clearly identify the portion that was modified, and shall indicate the running number of revision every time that a revised shop drawing is submitted.
- C505.37.4 The installation details shall be checked with the building works, the structure and other related trades to prevent conflicts that may cause delay of the project.
- C505.37.5 Size and scale of the shop-drawings shall be at least 1:100 scale except for enlarged scale details done for clarity, which shall be in conformity with international standards or as directed by the Employer.
- C505.37.6 Where required by the Employer, the Contractor shall prepare additional drawings, diagrams, etc., which in opinion of the Employer are considered necessary for a proper execution of the Works.

- C505.37.7 The Contractor shall not proceed with his work for a certain part or section, prior to the approval of the shop-drawings. Therefore, expense incurred because of modifications that have to be made as a result of lack of approved shop-drawings shall be borne by the Contractor.
- C505.37.8 Approval of the shop-drawings by the Employer shall not be construed as a complete check but will indicate only the general method of installation and its details are satisfactory.
- C505.37.9 The approval of the Employer shall not release the Contractor from his responsibility or his liability regarding the exact dimensions and further properties of the installations.
- C505.37.10 Shop-drawings submitted without sufficient detail shall be rejected and new submittal shall be required.
- C505.37.11 The Contractor shall submit 3 full scale copies of all shop-drawings for approval. If approved by the Employer, one copy shall bear the Employer's stamp indicating the date of approval, and shall be returned to the Contractor. After approval, 6 copies and a softcopy of all shop drawings will be provided and additional copies may be requested by the Employer as necessary.
- C505.38 Field Testing
- C505.38.1 Test all equipment upon completion of installation to ensure that the equipment operates satisfactorily and to conform to Contract Documents.
- C505.38.2 Field testing shall be required for all equipment furnished, installed or connected by the Contractor to ensure proper installation, setting, connection, and functioning in accordance with the plans, specifications and manufacturer's recommendations.
- C505.38.3 Testing shall be conducted in the presence of the Employer and, when necessary, under the supervision of equipment manufacturer's field Employer.
- C505.38.4 All tests recommended by the equipment manufacturer whether specified in this specification or not, shall be included, unless specifically waived by the Employer.
- C505.38.5 Testing shall include any additional tests required by the Employer to determine the conditions of that equipment, material and system to meet requirements of the specifications.
- C505.38.6 The Contractor shall maintain in triplicate, a written record of all tests showing date, personnel making test, equipment or material tested, tests performed and results. Three copies of test records shall be given to the Employer within the following day.
- C505.38.7 The Contractor shall notify the Employer two weeks prior to commencement of any testing, except for metering.
- C505.38.8 Contractor shall be responsible for any damage to equipment or material due to improper test procedures or handling test apparatus, and shall replace or restore any damaged equipment or material to original condition.

- C505.38.9 Safety devices such as rubber gloves and blankets, protective screens and barriers, danger signs, etc. shall be provided by the Contractor and shall be used to protect and warn adequately all personnel in the vicinity of the tests.
- C505.38.10 The Contractor shall furnish all testing equipment and provide proper temporary power source for testing purposes when normal supply is not available at the time of testing.
- C505.39 Operation and Maintenance Instructions Manual
- C505.39.1 The manual shall be prepared in hard cover binding in sets to be submitted to the Employer on acceptance of the completed work.
- Section 1 – Comprises submittal data of all equipment and materials that have been approved.
 - Section 2 – Comprises catalogues, categorized in groups, complete with installation operations and the maintenance manuals from the manufacturers.
 - Section 3 – Comprises filled out field test reports.
 - Section 4 – Comprises spare parts list and recommended spare parts.
 - Section 5 – Comprises maintenance and services schedule, and service and maintenance procedures for individual equipment listed daily, weekly, monthly, quarterly and yearly.
 - Section 6 – Comprises system operations manual
- C505.39.2 A draft copy of the manual shall be submitted to the Employer for approval first.
- C505.40 Works to Completion
- C505.40.1 The Contractor shall commission, clean down, and leave in full working order the works as specified.
- C505.40.2 As the installation proceeds the Contractor shall prepare 'as built drawings'. It shall be sufficient to modify these contract drawings showing any revisions which have been made and submit the marked-up prints to the Employer for approval.
- C505.40.3 The Contractor shall deliver to the Employer on completion of the works, manufacturer's literature, specifications, technical information and 'as built drawings' for all equipment installed.
- C505.40.4 Completion drawings shall be submitted in the form of two sets of CD's and six portfolios (A-1 or A-0 size) each containing complete set of drawings on approved scale indicating the work as - installed.

- C505.40.5 These drawings shall clearly indicate complete plant room layouts, ducting and piping layouts, location of wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, dampers, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The *Contractor* shall frame under glass, in the air conditioning plant room, one set of these consolidated control diagrams.
- C505.41 Fire Sealant
- C505.41.1 After erection of materials and equipment through wall and opening has been completed, it is the responsibility of the Contractor to fill up voids and openings with fire resistant materials which conform to NEC article 300-21 and ASTM equivalent Indian Standards (IS) to protect fire or smoke from spreading out from one room to other room or one floor to another floor through these voids and openings.
- C505.41.2 The fire barrier installation shall retain the integrity of fire resistance rated construction by maintaining an effective barrier against the spread of flame, smoke or hot gases through penetrations and openings. These fire sealants shall have fire rating compatible with fire compartmentation but cannot be less than two hours.
- C505.41.3 Covers or escutcheon plates shall be provided to cover the fire resistant seal wherever exposed, and shall be neatly placed to the satisfaction of the Employer's Representative.
- C505.41.4 Material from different fire barrier manufacturers shall not be installed in the same fire barrier system or opening.
- C505.41.5 After the erection of all piping, conduits, wirings, and raceways in the shaft, or any floor openings, the voids must be sealed off with fire barrier material, as approved by the Employer's Representative unless specified otherwise.
- C505.42 Standard and Reference
- C505.42.1 The fire barrier shall comply with the following codes and standards.
- | | | |
|----------------|---|---|
| (1) IS 12458 | : | Method of test for Fire Resistance Test of Fire Stop |
| (2) IS 1641 | : | Code of practice for Fire Safety of Building (General): Details of Construction |
| (3) IS 12777 | : | Method for classification of Flame Spread of products |
| (1) NEC 300-21 | : | Spread of Fire or Products of Combustion |
| (2) ASTM E814 | : | Standard Test Method for Fire Tests of Through-Penetration Fire Stops |
| (3) ASTM E84 | : | Standard Test Method for Surface Burning Characteristics of Building Materials |
| (4) ASTM E119 | : | Standard Test Methods for Fire Tests of Building Construction and Materials |

Certified test reports shall be provided to proof the compliance of this requirement.

C505.43 System Description

C505.43.1 Specified firestopping systems are based on a solid sealant only, or combinations of solid sealant, foam sealant, and refractory fibers of thickness required to attain hour ratings.

C505.44 Systems shall

C505.44.1 Provide a flexible seal to prevent passage of fire, smoke, toxic gases and water through openings, and prevent transmission of sound and vibration from the penetrating element to the structure.

C505.44.2 Provide hour ratings indicated and in accordance with ASTM E 814 or UL 1479.

C505.44.3 Comply with requirements of CBC Sections 709.6, 709.7, 709.8, 710.2, 710.3 and 710.6, and CBC Standards 7-1 and 7-5.

C505.45 Components

C505.45.1 The fire barrier materials shall have properties as follows:

- (1) The fire barrier materials shall be of a minimum 2-hour fire resistant rating or higher in accordance with type of construction walls or slabs.
- (2) The fire barrier materials must not be toxic during installation or in case of fire.
- (3) Easy to be dismantled and replaced in case of rearrangement.
- (4) Withstand vibration.
- (5) Easy installation.
- (6) Before and after fire spreads, the fire barrier materials must be strong enough.

C505.45.2 The Cable tray, Bus way and trunking pass through concrete wall shall be closed with Fire barrier composite sheet (3M CS-195 or equivalent) with cut to suit and fit to the Cable tray size and cover with composite cover strip. At cable, bus way edge and barrier sheet joint shall be sealed with Fire barrier Sealant (3M CP-25WB or equivalent). Medium density mineral wool will be packed up to full depth of the void between both edges of fire barrier walls.

C505.45.3 The conduit pass through concrete wall shall be filled with medium density mineral wool packing to full dept of wall and compressed to 80kg/m³ at outside and close hole with Fire sealant.

C505.45.4 The Fire barrier sheet shall not be less than 25mm thick and cut to fit closely around the outside surface of the Tray, Conduit and Busway as much as possible.

C505.45.5 The steel plate, corrosion painted, 12mm thick as minimum, shall be used for Cable tray, Conduit, Bus way and trunking pass through concrete floor. The steel plate shall be cut to fit to the cable tray, bus way and conduit as much as possible, installed with support to suit to the shaft dimension and strong enough for holding in position.

C505.45.6 Fire barrier composite sheet (3M CS-195 or equivalent) will be cut and fix to the shaft on the top of steel plate fit to the Cable tray size and cover with composite cover strip. At cable, bus way edge and barrier sheet joint shall be sealed with Fire barrier Sealant (3M CP-25WB or equivalent). Medium density mineral wool will be packed and full depth of the void between both edges of fire barrier walls.

1	Cylinder manifolds	Rexarc, Wittgas, BOC, Praxair
2	Flashback arrestors	Rexarc, Wittgas, BOC
3	Station Outlets with regulators and flowmeters	Rexarc, Wittgas, Messer, Esab, EWM, Praxair
4	Explosion proof pressure switch	Rexarc, wittgass, BOC, Indfoss, Switzer
5	Fuel gas Relief valves	Rexarc, Wittgas, BOC
6	Oxygen relief valves	Rexarc, Wittgas, BOC
7	Hand torch	Rexarc, Wittgas, BOC, Esab, Messer
8	Gas economizer	Rexarc, Wittgas, BOC
9	Hose coupling	Rexarc, Wittgas, BOC
10	Ball valves	Rexarc, Wittgas, BOC, atlascopco, RB
11	NRV/GV	Rexarc, Wittgas, BOC, Praxair AUDCO/ZOLOTO/LEADER/SANT /HAWA/ADVANCE/CASTLE/ RB
12	Condensate drain trap	Spirax Sarco, Armstrong, Ultrafilter
13	Expansion Joint	Metraflex, Resistoflex, Kanwal(easyflex)

14	Welding Rods	ADOR
		Cosmos
		Esab
		Advani
15	Fastner	Fisher
		Hilti
		OM
16	Flexible Drops	Easy Flex
		Newage
		Dungaflex
17	Stainless Steel Pipe	Jindal
		Prakash
		Tata Steel
18	G.I. / M.S. Pipes (IS : 1239 / IS : 3589)	Jindal
		Tata Steel
		SAIL
19	Butterfly Valve	Audco
		Danfoss
		Honeywell
		Indian Valve Company
20	Fire Sealant	Birla 3M
		Hilti
		Promat

C600 COMPRESSED AIR SYSTEM



C601 SYSTEM DESCRIPTION

- C601.1 Low pressure compressed air (LPCA) will be provided to satisfy ship/vessel and submarine pneumatic processes. The system will supply compressed air to cope points along jetty and FIC bays. The air quality shall be of Class 2 as per ISO 8573-1 and at a minimum pressure of 700 kPa for LPCA at the cope points.
- C601.2 The low pressure compressed air system shall be supplied from compressor house via reticulated compressed air line of suitable diameter.
- C601.3 The LPCA shall be distributed to jetty cope points and other service connections using walk-through service ducts within the jetty and underground service ducts in locations on shore.
- C601.4 For maintenance purposes suitable bypass line, equipped with shut off valves, will be provided to allow a particular portion of berthing facility to be shut down. Suitable valve connection points shall be provided in concrete service pits for the future connections to other areas.
- C601.5 Scope of Work
- C601.5.1 This Section specifies the scope of work, supply, design and installation, testing, commissioning of the LPCA and air distribution as indicated in the drawings.
- C601.5.2 The Compressed Air system include the Air Compressors complete with air/oil separator, oil cooler, oil strainer and oil filter, air dryers, receivers, air filters, pipes and pipe couplings, power cabling, conduiting, VSDs, electric controls and measuring instruments and pressure gauges, the associated air distribution network and all other accessories to make the equipment fully functional.
- C601.5.3 The Contractor shall also include in the scope of supply, any other accessories, which shall contribute to improved performance, reliability and maintainability of the equipment which is not listed in the BOQ and specifications.
- C601.5.4 Air distribution network shall include the stainless steel piping with all accessories such as valves, pipe couplings and fittings, measuring instruments, filters and regulators, pipe supports and hangers, expansion bellows, condensate drains, quick release couplings and all other accessories to make the distribution complete from compressor house to jetty and FIC bays to serve air distribution.
- C601.5.5 The boundary limit for air distribution network shall be as indicated in drawings. The Contractor should include the provisioning of valves and other required accessories at the boundary limit in his scope.
- C601.5.6 Air distribution network should be complete with air reservoirs, auxiliary reservoirs, Non return valves and safety valves wherever applicable.
- C601.5.7 The system shall be designed with appropriate instrumentation to provide fully automated operation from a centralized control facility which shall be located as shown in the drawings.

C601.5.8 A compressor protection system shall be provided with sensors that monitor and protect the compressors against abnormal operating conditions. The control system shall be designed to allow manual and automatic rotation of each compressor to distribute wear. Sufficient primary temperature and pressure indicators shall be provided for the compressors and dryers to facilitate the locating of faults. Pressure indicators and transmitters shall be provided at each tapping point to ensure the system is able to maintain the required pressure automatically.

C601.6 Standards

C601.6.1 The entire supply shall comply with the requirements of the standards in force on the day of start-up. The compressor must also comply with IS 1217, IS 6206 and IS 4758 standards

C601.6.2 Relevant Codes and Standards

IS 6206	Guide For Selection, Installation And Maintenance Of Air Compressor Plants with Operating Pressures Up To 10 Bars.
Is 4758	Methods of Measurement Of Noise Emitted By Machines.
Is 7938	Specification For Air Receivers For Compressed Air Installation.
Is 15879	Breathing Air compressor Package – Specification
Is 11780	Code For Selection And Testing Of Rotary Screw Air Compressor
Is 12258	Technical Supp-Ly Condition For Air Screw Compressors

A. American Society of Mechanical Employers (ASME):

B1.20.1:	Pipe Threads, General Purpose (Inch)
B16.11:	Forged Fittings, Socket-Welding and Threaded
B16.20:	Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral Wound, and Jacketed.
B16.34:	Valves - Flanged, Threaded and Welding End.
B16.39:	Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300.
B16.9:	Standard for Factory-Made Wrought Steel Buttwelding Fittings.
B31.1:	Power Piping
B36.10M:	Standard for Welded and Seamless

	Wrought Steel Pipe
B40.1:	Pressure Gauges and Gauge Attachments
B46.1:	Surface Texture, Surface Roughness, Waviness and Lay
BPVC SEC IX BPVC:	Section IX-Welding and Brazing Qualifications
BPVC SEC VIII D1 BPVC:	Section VIII-Rules for Construction of Pressure Vessels Division 1.

B. ASTM International (ASTM):

A106/A106M:	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
A182/A182M:	Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
A193/A193M:	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications.
A194/A194M:	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
A269:	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
A312/A312M:	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
A351/A351M:	Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
A380:	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
A403/A403M:	Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
A53/A53M:	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
B127:	Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
B164:	Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.

- B165: Standard Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube.
- B564: Standard Specification for Nickel Alloy Forgings
- E11: Wire Cloth and Sieves for Testing Purposes
- E381: Macrotech Testing Steel Bars, Billets, Blooms, and Forgings
- C. American Welding Society (AWS):**
1. D1.1/D1.1 M:Structural Welding Code – Steel AWS Z49.1 Safety in Welding and Cutting and Allied Processes.
- D. International Organization for Standardization (ISO):**
- 2151: Acoustics - Noise Test Code for Compressors and Vacuum Pumps - Engineering Method (Grade 2)
- E. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):**
- SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation.
- SP-69: Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard).
- SP-71: Gray Iron Swing Check Valves, Flanged and Threaded Ends.
- SP-80: Bronze Gate, Globe, Angle and Check Valves.
- F. National Electrical Manufacturers Association (NEMA):**
- ICS 2: Standard for Controllers, Contactors, and Overload Relays Rated 600 V.
- ICS 6: Enclosures
- MG 1: Motors and Generators
- G. National Fluid Power Association (NFLPA):**
- T3.12.3: Pneumatic Fluid Power - Pressure Regulator - Industrial Type.
- H. Pipe Fabrication Institute (PFI):**
- ES 22: Color Coding of Piping Materials

I. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):

1650: Seismic Restraint Manual Guidelines for Mechanical Systems, 2nd Edition.

J. Society of Automotive Employers International (SAE):

AMS7276: Rings, Sealing Fluorocarbon (FKM) Rubber High-Temperature Fluid Resistant Low Compression Set 70 to 80.

AS4841: Fittings, 37 Degree Flared, Fluid Connection

AS4842: Fittings and Bosses, Pipe Threaded, Fluid Connection

AS4842/1: Fittings, 37 Degree Flared to Pipe Threaded, Fluid Connection

AS4843: Fittings, Beaded, Fluid Connection

AS4843/1: Fittings, Beaded to 37 Degree Flared, Fluid Connection

AS4843/2: Fittings, Beaded to Pipe Threaded, Fluid Connection

AS4875: Fittings, Straight Threaded Boss, Fluid Connection

AS4875/1: Fittings, Straight Thread Boss or Flanged to 37 Degree Flared, Fluid Connection.

AS4875/2: Fittings, Flanged to Beaded, Fluid Connection

J514: Hydraulic Tube Fittings

K. The Society for Protective Coatings (SSPC):

SP 10/NACE No. 2:Near-White Blast Cleaning

C601.7 Air Compressors

C601.7.1 The LPCA compressors shall be of oil- free rotary screw type with integrated VSD drive complete with all integral controls for remote control and monitoring through SCADA and safety devices and shall be rated at the performance stated in the Equipment Schedule (BOQ) with a tolerance of $\pm 3\%$ of flow (ISO1217 or equivalent).

C601.7.2 The compressors shall be suitable for 24-hours continuous operation per day with cyclic on/off with start/stop control from pressure switches. The compressors shall be complete with control panel featuring manual lead/lag selector switch, motors, and starters.

- C601.7.3 The motor control panel shall be incorporated with automatic daily lead-lag sequence of the air compressors for optimum efficiency operation. The compressors shall be in full-capacity standby mode, and arranged so that automatic changeover takes place if the selected air compressor fails to start within a pre-determined length of time. On initial start-up and intermediate increase of compressed air demand consumption, both compressors shall run until the desired compressed air pressure is reached. The operation of the compressor shall be cut out by high pressure cut-out or overload status.
- C601.7.4 A compressor protection system shall be provided with sensors that monitor and protect the compressors against abnormal operating conditions. The control system shall be designed to allow manual and automatic rotation of each compressor to distribute wear. Sufficient primary temperature and pressure indicators shall be provided for the compressors and dryers to facilitate the locating of faults. Pressure indicators and transmitters shall be provided at each tapping point to ensure the system is able to maintain the required pressure automatically. Subsystems supplying to instrument air shall be provided with local air quality instrumentation as appropriate.
- C601.7.5 Control Panel: Control unit panel shall conform to NEMA ICS 6, floor or frame mounted, factory designed, and assembled, and shall be provided complete. The panel shall be fabricated of formed stretcher leveled sheet steel, reinforced, and assembled into a rigid unit. Gasketed access doors shall be provided as required. Panel shall be factory finish painted. The panel shall meet NEMA 12, requirements.
- C601.7.6 Panel shall contain electric and safety control work required, including either alarm annunciator or individual labeled pilot lights arranged in a group. Panel shall contain alarm device with light and silencing. Generalized arrangement in accordance with drawings.
- C601.7.7 Panel shall contain start and stop buttons (the latter with lockout feature), discharge air pressure gage, control test switch and lights, reset button, green unit running light, and control selector switch.
- C601.7.8 The following indicators/selectors switches shall be included in the compressor motor control panel:
- (a) Running hour meter
 - (b) Manual/Auto selection switch
 - (c) Pressure indicator
 - (d) Temperature indicator
 - (e) Duty/standby selection switch with automatic sequence control
- C601.7.9 The compressors shall be pulsation-free and the noise level generated from the machines shall not exceed 75 dB(A) under normal operating condition; measured under field condition at a distance of 1m with maximum deviation of ± 3 dB(A).

- C601.7.10 The main drive motor for each compressor shall be having the capacity indicated, with a continuous service factor of 1.0. Size the motor so that the name plate HP (kW) rating is not exceeded under the entire range of operating conditions specified. Efficiency and losses shall be determined in accordance with IEEE 112. Unless otherwise specified, horizontal polyphase squirrel cage motors rated one to 125 horsepower shall be tested by dynamometer Method B as described in Section 6.4 of IEEE 112. Motor efficiency shall be calculated using Form B of IEEE 112 calculation procedures. Polyphase motors larger than 125 horsepower shall be tested in accordance with IEEE 112 with stray load loss determined by direct measurement or indirect measurement (test loss minus conventional loss). The efficiency shall be identified on the motor nameplate by the caption NEMA Nominal efficiency or NEMA Nom eff. Electrical service will be as indicated. Motor shall be designed for reduced voltage starting, allowing for characteristics of the connected load, and shall start without undervoltage tripping. Provide resistance temperature detectors (RTD) attached to or imbedded in motor winding for control system. The motor shall meet the requirements of NEMA MG 1 with Class F insulation. Provide space heaters for protection of windings during motor shutdowns.
- C601.7.11 The motor shall be high efficiency and rated for IP55 TEFC protection against dust and humidity.
- C601.7.12 Silencers, lubricating system, cooling system, control system, and driver shall be mounted as part of the package. Provide a common base frame for the compressor system and driver. Provide a sound enclosure over the compressor and driver. Equipment shall be designed for economical and rapid maintenance. Casing components, bearing housings, and other major parts shall be shouldered, dowelled, or designed with other provisions to facilitate accurate alignment or reassembly. Shaft seals and bearings shall be accessible for inspection or replacement with a minimum of disassembly.
- C601.7.13 The compressor shall be mounted on steel deck/frame and enclosed in a canopy. The mounting and enclosure shall be provided with anti-vibration and sound proofing treatment.
- C601.7.14 Sound Attenuating Enclosure: The compressor package, including the driver motor, shall be contained within a noise reducing enclosure. Design of the enclosure shall be such as to limit noise transmission to 84 dBA or less at a distance of one meter from the compressor in any direction.
- C601.7.15 Enclosure Frame: The enclosure frame shall be designed to support the weight of the sound suppression panels and easily demountable. Connections to the base frame shall be designed to allow the enclosure frame to be detached and lifted away without damage to the connections, enclosure frame or base frame, and to allow accessibility and replacement of any component.

- C601.7.16 Panels: The panels shall be of rigid construction to allow repeated access without damage or distortion. Sound absorbing material shall be mineral fiber, treated to preclude shedding of fibers. Other approved insulation may be used except that polyurethane foam shall not be permitted. Top panels shall be secured to the enclosure frame with quick disconnect fittings and fabricated to allow easy hand removal for maintenance. End and side panels shall be hinged or lift out with positive closure latches. Panels shall be designed to allow the maximum access area when opened. Provide acoustic seals as required. Controls and instrumentation mounted on the panels shall have flexible connections for panel opening and disconnects for enclosure removal. Disconnects shall be of the male-female plug type. Panels shall split around all piping connections to allow enclosure removal without detaching piping. Controls shall be visible and operable from outside the enclosure.
- C601.7.17 Ventilation: Fan(s) and sound baffled ventilation grilles shall be provided as part of the enclosure. Ventilation shall be sufficient to limit interior temperature to that required for cooling the motor.
- C601.7.18 Isolating Pad: If specifically recommended by the compressor manufacturer, each compressor steel or iron base frame shall be mounted on a neoprene waffle or rib type isolator pad which extends uniformly and continuously along the base mounting surface. The neoprene material shall be of bridge bearing pad quality neoprene and shall be formulated for 40 durometer hardness. The maximum bearing pressure on the isolating pad shall be 50 psi (345 kPa). The pads shall be composed of two layers or 5/16 inch (8 mm) neoprene bonded to and sandwiching 16 gage galvanized steel. Compressor bolt down through the pad shall be accomplished using 1/4 inch (6 mm) thick neoprene impregnated duck washers. Neoprene bushings are not acceptable.
- C601.7.19 Compressor Casings: Casings shall be cast iron, ductile iron, cast steel, or fabricated steel. Casing stresses shall be within the limits allowed by ASME BPVC SEC VIII D1. Casings, supports, and baseplates shall be designed and fabricated to preclude excessive and injurious distortion from temperatures, pressures, and forces encountered in service conditions. Provide jackscrews, lifting lugs, eyebolts, guide dowels, and casing alignment dowels to facilitate disassembly and reassembly. When using jackscrews for parting contacting faces, relieve one of the faces by counter boring or recessing to prevent marring the face, which result in leaking or improper fit. Provide lifting lugs or eyebolts for removable portions of the casings. Flanged casing connections for external piping shall conform to ASME B16.1 or ASME B16.5. Threaded connections for external piping shall conform to ASME B1.20.1. Air compression portion of the casing shall be one-piece and shall be provided with integral coolant passages and a large inlet port. Gear cases shall be enclosed, accessible, force lubricated, and designed with seals and slingers to keep oil out of air system.
- C601.7.20 Shafts: Shafts shall be of forged or rolled alloy steel and shall have a machined finish throughout their entire length. All rotating components shall be positively secured to shafts by approved mechanical means or interference shrink fits.

- C601.7.21 Rotors: Rotors shall be steel, and of one-piece construction, with an asymmetric profile to minimize leakage losses, and ensure high efficiency. Rotors shall be treated for corrosion resistance. If rotors are welded to the shaft, the assembly shall be stress relieved and heat treated for proper strength. Rotors shall be dynamically balanced to ensure vibration-free operation.
- C601.7.22 Gears: Gears shall be of alloy steel, ANSI/AGMA 2009 and ANSI/AGMA 2011 Quality Number 12 or better for both bull and pinion gears. Gears shall be hardened to 275 Brinell for bull gear and 320 Brinell for pinion, unless otherwise approved. Gears shall be ground to the required contours, checked for proper contact during assembly at the factory, and shall not require a break-in period in the field for proper operation. All gears shall be pressure lubricated. Timing gears shall be provided on the rotor shafts to maintain the rotors in correct relative position. The compressor design shall allow the timing gears to absorb no more than 10 percent of the total input power at full load.
- C601.7.23 Seals: Separate air and oil shaft seals shall be provided to confine air in the casing and prevent contamination of the air stream by lubricating oil. Shaft seals shall be the restrictive ring type. The seal rings shall be stainless steel, brass, or carbon, and retainers shall be made of stainless steel. Provide an air space vented to the atmosphere between the air and oil seals. Seals shall be suitable for all operating conditions including suction throttling, start-up, and shutdown.
- C601.7.24 Thrust Bearings: Thrust bearings shall be anti-friction ball or roller type or hydrodynamic (fluid film) type. Anti-friction bearings shall have an L-10 life of 80,000 hours in accordance with ABMA 9 or ABMA 11. Axial rotor thrusts due to air compression shall be absorbed by main thrust bearings or transferred to auxiliary thrust bearings by a load balancing arrangement. Hydrodynamic thrust bearings shall be Kingsbury type or other approved type and shall be adequate to accommodate all operating conditions. Speed increaser bull gear thrust bearings shall be sized for equal thrust in both directions and shall be adequate for any axial loads transmitted through the driver coupling.
- C601.7.25 Radial Bearings: Radial bearings shall be anti-friction roller or ball type or hydrodynamic type. Anti-friction bearings shall have an L-10 life of 40,000 hours in accordance with ABMA 9 or ABMA 11. Hydrodynamic bearings shall be precision bored sleeve or pad type, designed for easy replacement by a split design or axially removable arrangement. High speed hydrodynamic pinion bearings shall be anti-oil whip, tilting pad type. Hydrodynamic bearing design shall provide low vibration and sufficient damping at rated speed and all operating modes, including rated capacity and unloading down to 20 percent of unloaded power.
- C601.7.26 Speed Increaser: The speed increaser shall be an integral part of the compressor unit and shall include the main drive shaft and bull gear. The main drive shaft shall be supported through anti-friction bearings.

- C601.7.27 Intercoolers, Aftercooler, Bypass Cooler, and Oil Coolers: Intercoolers, aftercooler, bypass cooler, and oil cooler shall include ASTM B 111/B 111M admiralty brass or other corrosion resistant tubes in ASTM B 171/B 171M admiralty or steel tube sheets and baffles for optimum cooling and fouling resistance using water. Provide an intercooler between stages of compression factory assembled on unit base with piping. Intercoolers, aftercooler, bypass cooler, and oil cooler shall be factory tested at 1.5 times operating pressure. External intercoolers and aftercooler shall be constructed in accordance with ASME BPVC SEC VIII D1 requirements and be ASME code stamped for 150 psig (1034 kPa (gage)) working pressure. Intercoolers and aftercooler shall be capable of one piece bundle removal. Intercoolers and aftercooler shall be equipped with an integral or direct connected moisture separator with condensate trap assembly. Design intercoolers and aftercooler for 20 and 15 degrees F (11 and 8 degrees C) approach, respectively; however, the approach temperature used to size the coolers shall be reduced if required to meet aftercooler maximum air outlet temperature specified. Nonstandard coolers shall be provided if required to meet the aftercooler maximum air outlet temperature requirement. All coolers shall be of counter-flow design, with a fouling factor of 0.002 for both sides of the coolers.
- C601.7.28 The pre-cooler with fins shall be of stainless steel.
- C601.7.29 External air intake pre-filters shall be fitted and details or replacement units, their cost and useful life shall be provided with the Tender.
- C601.7.30 Inlet air to the compressor shall be taken from ambient air.
- C601.7.31 A warning sign, 4mm thick plastic plate, with the following wording in English of character height not less than 16mm to be added in the vicinity of the air compressors;
- C601.7.32 “This compressor is automatically controlled and may start without warning”.
- C601.7.33 The Contractor shall submit the detailed format of the above warning sign for approval.
- C601.8 Data sheet

DATA SHEETS FOR LPCA AIR COMPRESSORS	
Service	Low Pressure Compressed Air
Type	Oil free Rotary Screw Air cooled Compressors with VSD
Gas Handled	Atmospheric Air
Volume: NM ³ /hour	2500
<u>Inlet Conditions</u>	
Pressure	Atmospheric
Temperature (°C)	Max 40 °C

DATA SHEETS FOR LPCA AIR COMPRESSORS	
Relative Humidity (%)	Max 100 %
<u>Discharge Conditions</u>	
Pressure (Bar G)	8.6
Temperature (°C)	Not more than 45°C
Rated Speed (rpm)	Not more than 1450 rpm
Volumetric Efficiency (%)	95%

C601.9 Air Tanks/Receiver

C601.9.1 Air receivers shall be constructed in accordance with ASME Boiler and Pressure Vessel Code Section VIII and Indian Standard: 7938-1976. Each air receiver shall be of horizontal welded stainless steel ASTM A240 grade 316 type complete with inlet and outlet connection, pressure relief (safety) valve, inspect opening, tapping for drain valve, and pressure gauge. The receiver shall also confirm to BS5169 and BS5750 and have a capacity as specified in the Equipment Schedule.

C601.9.2 The receivers shall be suitable for service pressure of 10 Kg/cm² and shall have an inspection hole at the top as well as an automatic condensing bleeder. The inlet and outlet pipe flanges shall be designed for the full rated output of two compressors working separately. These shall be equipped with a 0 to 15 Kg/cm² pressure gauge as well as a safety valve. Air receivers shall be designed to withstand a minimum of 1.5 times the working pressure.

C601.9.3 Each receiver shall bear a 4mm thick metal plate label on which the following indication wording in English of characters height not less than 6mm shall be engraved:-

- (a) Manufacturer: _____
- (b) Model/Serial Number: _____
- (c) Normal Design Pressure: _____ bar
- (d) Maximum Design Pressure: _____ bar
- (e) Maximum Design Temperature: _____ 0C
- (f) Hydraulic Test pressure: _____ bar
- (g) Date of Mfg. & Test: _____

C601.9.4 The Contractor shall submit the detailed format of the above label for approval.

- C601.10 Factory Tests
- C601.10.1 Examine exterior of vessels by liquid penetrant or magnetic particle test; no defects shall be permitted. Furnish certified (non-destructive examination) NDE report for medium pressure vessels. Vessels shall undergo hydrostatic testing at the factory. Provide certification of factory tests.
- C601.11 Finish
- C601.11.1 After factory tests, clean each vessel to oil-free condition. Abrasive blast interior and exterior to near-white condition in accordance with SSPC SP 10/NACE No. 2. Vacuum clean surfaces to remove dust and debris. Check surfaces with black light to ensure there is no oil. Apply 2 or 3 coats of epoxy coating 8 mils (0.20 mm) minimum dry film thickness, with white finish coat for the interior. Exterior finish shall be [standard factory finish] [two coats of rust inhibitor primer and one coat epoxy enamel] with gray finish coat.
- C601.12 Accessories
- C601.12.1 Equip each receiver with pressure gage, drain valve, and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX code stamped pressure relief valve set as indicated and piped to discharge in a safe manner. Piping shall conform to [400] psig at [150] degrees F ([2,758] kPa (gage) at [66] degrees C) standards. Provide each receiver with internal or external blowdown and drain line with manual valve in accessible location, or with extension stem, discharging through a visible open sight drain. Do not manifold cylinder drain piping together. Attachment welds to receiver shall not be permitted.
- C601.13 Desiccant Type Air Dryer
- C601.13.1 Heated blower with zero purge cooling Desiccant type of air dryers shall be provided in the compressed air system with a Pressure dew point of – 40 C. Each dryer shall have controls to allow manual and automatic operation. There shall be provision to manually alternate from lead to lag operation compressor.
- C601.13.2 The dryer should have a pressure drop below 0.2 bar and employ energy management control with built-in Dew point Dependent Switching.
- C601.13.3 The dryer should have a complete Stainless steel wide vessels based design with insulated vessels and SS Valves. The frame should have forklift slots and lifting eyes for easy handling.
- C601.13.4 The air dryers shall have built-in automatic drain valves so that the unit operates with continuous drain to a separator, with periodic blow down to drain condensate.
- C601.13.5 The air dryer shall employ the dew point control panel to sound the alarm if present dew point value (adjustable) is too high.
- C601.13.6 The continuous operating time of one desiccant drum shall not be less than 8 hours under the specified conditions. However, based on ultimate life and other parameters, the operating time shall be optimized.

- C601.13.7 The dryer shall have two desiccant drums, regeneration equipment, instrumentation, piping and other accessories. While one desiccant drum is being operated, the other drum will be automatically regenerated. When using an electric heater for regeneration integrated into the desiccant drum, this heater shall be capable of being maintained without affecting dryer operation.
- C601.13.8 The control panel should monitor and display all parameters and should be IP 54 rated. It should have a graphical high-definition color display with pictograms and LED indicators for key events.
- C601.13.9 Vessels shall be of welded steel, having indicated working pressure, at 450 degrees F (232 degrees C), ASME labeled conforming to ASME BPVC SEC VIII D1, with flanged or threaded fittings, air diffusers to effectively prevent channeling of the desiccant, and stainless steel screens. Diffusers and screens shall be provided at the top and bottom of each vessel. Each vessel shall have top fill and bottom drain ports to facilitate desiccant replacement. Vessels shall be supported on a structural steel frame complete with floor stand.
- C601.13.10 Provide moisture indicator, shuttle valve, and pressure relief valve. Shuttle valve shall be cycle tested. Heaters shall be electric resistance type. Blowers shall be electric motor driven. Controls and instrumentation shall include tower pressure gauges, tower status lights, switching failure alarm, and NEMA 4 electrical enclosure.
- C601.13.11 Provide the air dryer manufacturer's control package. At a minimum, controls shall provide air discharge dew point temperature control, tower regeneration cycle control, heater control, filter status, valve position, and diagnostic mode for stepping through the dryer's operational sequence to verify proper function and performance, and malfunction notification.
- C601.13.12 Desiccant shall be in tablet form which will not nest or cake. Provide a supply of the air dryer manufacturer's recommended desiccant in unbroken shipping containers equal to not less than four charges of desiccant for each dryer.
- C601.13.13 All parts requiring maintenance shall be readily accessible and removable. All components shall be corrosion resistant and factory painted. Test air dryers at the factory to ensure proper operation. Certify satisfactory completion of tests.
- C601.14 Filters
- C601.14.1 The filter should be large enough to ensure that the air exits the filter at low velocity and does not carry over coalesced liquid.
- C601.14.2 To avoid liquid carryover, the coalesced liquid should not be allowed to build up in the filter housing above the level of the bottom of the filter tube. To serve this purpose, automatic drains with all coalescing filter need to be provided.
- C601.14.3 The flow direction through the Microfibre filter tube must be inside-to-outside to permit the liquid to drip from the outside of the tube to the drain in the filter housing.

- C601.14.4 For maximum protection of the desiccant dryer, a two-stage filter system with automatic drains should be installed upstream from the dryer. To protect downstream delivery points from abrasive desiccant particles, a high efficiency filter with high solids holding capacity should be installed downstream from the dryer.
- C601.14.5 For HPCA, With respect to air quality IS/ISO 8573-1 (2, 2, 2) air, corresponds to air which has been filtered and dried to a maximum 1 micron particle size, -40° C pressure dew point, and a maximum 0.1 mg/m³ of oil. It is expected that this quality level can be achieved by adding two stages of pre-filters of Coalescing filters with efficiency of 95% and 99.995% before the dryer.
- C601.14.6 For HPCA, to achieve the desired breathing air type quality, the after-filter chain should be particulate filter + high efficiency coalescing filter + Adsorber to remove vapor from gas.
- C601.15 Air Pre-Filters
- C601.15.1 Air filters shall be provided to fulfil the minimum requirements as per ISO 12500 compressed air filter standard. Pre air filters shall be rated to capture 4 to 10 microns or larger particle size and water moisture before entering to the compressor. Pressure drop across the intake air filters shall be kept less than 7 psi (includes all stages) to prevent a throttling effect and a reduction in compressor capacity. Differential pressure gauges upstream and downstream of the filters shall be provided to enable operators to monitor the condition of the air filters.
- C601.15.2 Two stages of pre-filtration to be provided with efficiency of 90% and 99.99% respectively.
- C601.15.3 Pre-filter shall be assembled on the air intake side of the wet gas inlet of the desiccant air dryer. The steel housing of the pre-filter shall comply BS 5500, and the filter medium shall be composed of layers of fine glass fibers integrally epoxy bonded as a strong sheet to remove particle down to 0.01 micron. The grade of filtration shall be suitable for use with desiccant type air dryer and if required, two stage of filtration can be provided.
- C601.15.4 The rated differential pressure and operating temperature of the pre-filter shall be consistent with the intended rating of the compressed air plant.
- C601.15.5 The pre-filter shall consist of automatic drain valve and sump to facilitate periodical draining of the housing either automatically or manually.
- C601.16 Air After-Filters
- C601.16.1 After-filter shall be assembled on downstream side of the air dryer to filter to remove particulate matter (e.g. dust, dirt) with diameters larger than 0.01 micron, from the treated compressed air supply stream.
- C601.16.2 The rated differential pressure and operating temperature of the after-filter shall be consistent with the intended rating of the compressed air plant.
- C601.16.3 The after-filter shall consist of automatic drain valve and sump to facilitate periodical draining of the housing either automatically or manually.

- C601.17 Point of use Filter and Regulator
- C601.17.1 The point of use filter and regulator assembly to be provided where compressed air is intended to be used for instrumentation.
- C601.17.2 The point-of-use filters will remove dirt and oil which may have been in the distribution lines, as well as water that has condensed downstream from the main filter.
- C601.17.3 If there is a pressure regulator at the end-use point, the filter should be installed immediately upstream from the regulator.
- C601.17.4 Flow direction through the element is inside-to-outside for optimum oil and water removal.
- C601.17.5 An automatic drain to be installed for maintenance free operation.
- C601.18 Compressed Air Drain Assemblies
- C601.18.1 Condensate Float Drain trap of Stainless-Steel type shall be provided at the base of each vertical branch, main moisture separators air receivers, and at intervals not exceeding 100 m of horizontal pipe run.
- C601.18.2 The assembly shall consist of an isolating valve, strainers, compressed air trap and liquid discharge pipe. The discharge pipe shall be provided with a ball valve and extended to the nearest gully or drain.
- C601.18.3 A pressure balance pipe shall be fitted between the branch main, separator inlet or air receiver where shown.
- C601.19 Compressed Air Piping
- C601.19.1 Due to the corrosive environment careful consideration is given to proper material selection for all distribution piping and components. Low pressure compressed air piping will be Schedule 40S Stainless steel ASTM Grade 316.
- C601.19.2 Piping shall be clearly labelled and color coded for the service and function. Supply and distribution piping shall be schedule 40S stainless steel piping, with ANSI/ASME B36.19 stainless steel weld type fittings.
- C601.19.3 Each header or main should be provided with outlets as close as possible to the point of application. This permits the use of the shorter hose lengths and avoids large pressure drops through the hose. Outlets should always be taken from the top of the pipe line to prevent carry-over of condensed moisture to tools.
- C601.19.4 All piping should be sloped so that it drains toward a drop leg or moisture trap in order that condensation may be removed to prevent its reaching air-operated devices in which it would be harmful. A slope of about (2.0 mm/m) may be used, with drains provided at all low points. These may consist of a short pipe with a trap or drain at the bottom. All branches taken from the compressor discharge line shall be from the top of the header.

- C601.20 Inlet piping
- C601.20.1 Air inlet- A clean, cool, dry air should be supplied for air compressor. The compressor inlet should be taken from outside air. The filter should take air from at least 2m or more from the ground or roof and should be located a few meters away from any wall to minimize the pulsating effects on the structure.
- C601.20.2 The air inlet shall always be located far enough from steam, gas, or oil engine exhaust pipes to ensure that the air will be free from dust, dirt, moisture and contamination by exhaust gases. Silencer shall be provided according to noise limitation.
- C601.20.3 The inlet piping should be as short and direct as possible, with long radius elbows where bends are necessary. The inlet piping should be the full diameter of the intake opening of the compressor.
- C601.20.4 For compressors, the air piping shall be arranged for best performance to achieve uniform air velocity over the entire area of the compressor inlet. To attain this condition, there should be a run of straight pipe prior to the compressor inlet, with a length equivalent to about four diameters. It is frequently necessary to reduce the inlet-pipe diameter to match a compressor inlet flange of lesser diameter.
- C601.21 Discharge Piping
- C601.21.1 The discharge piping is considered to be the piping between the compressor and the aftercooler, the aftercooler separator, and the air receiver. The discharge pipe shall be the full size of the compressor outlet or larger, and it shall run directly to the aftercooler if one is used. If an aftercooler is not used, the discharge pipe shall run directly to the receiver, the latter shall be set outdoors, and as close to the compressor as is practical.
- C601.21.2 The discharge pipe shall be as short and direct as possible, with long radius elbows where bends are necessary, and shall have as few fittings, as possible. Unnecessary pockets shall be avoided. If the design cannot avoid pockets between the compressor and the aftercooler or receiver, it shall be provided with a drain valve or automatic trap to avoid accumulation of oil and water mixture in the pipe itself.
- C601.21.3 Piping after the air receiver will have accessories dictated by the application (dryers for oil-free air) pre-separators, after-separators for the dryers, and so on. The installation of a safety valve between the aftercooler and the compressor discharge piping shall be considered.
- C601.21.4 For compressor, if it is necessary to increase the pipe diameter just beyond the compressor discharge flange, this transition shall be gradual.
- C601.22 Valves and Fittings
- C601.22.1 Isolation valves shall be full port ball valves for pipes 50 mm (2 inch) or less in dia. and butterfly valves for pipe sizes 65 mm (2-1/2 inch) or greater in dia. Isolation valves in the main pipelines shall be of the gate valve type conforming to IS 10611. Isolation valves on the cope header, drain and balance lines shall be of the ball valve type conforming to IS 11792.

- C601.22.2 A minimum ANSI pressure class 150 is recommended for the supply pipe, fittings and valves.
- C601.22.3 Air traps shall be Spirax Sarco CA14 SS float-type trap with ¾ inch connections or equivalent approved. All air traps to be installed following hydrostatic testing.
- C601.22.4 Expansion joints shall be located as shown on the drawings. Expansion joints shall be of the metallic bellows type, designed and supplied by a manufacturer specializing in such items, and shall comply with the American Expansion Joint Manufacturer’s Standard or other approved standard. The installation of each bellows, including the positioning of adjacent anchors and guides, shall be strictly in accordance with the manufacturer’s recommendations.
- C601.22.5 Each bellows shall be designed in accordance with the following table:

	250 DN	100 DN
Minimum pressure rating:		
Normal	750 kPa	
Maximum (pressure relief valve setting)	1500 kPa	
Minimum axial compression (from as-installed position)	50 mm	35 mm
Maximum spring rate	30 N/mm	50 /mm

- C601.23 Control System
- C601.23.1 The system shall be equipped with appropriate instrumentation providing fully automated operation including existing compressors from a centralized control facility located at Utility Complex-2 or from some other place located at base through SCADA.
- C601.23.2 All monitoring and control functions shall be capable via one interface with overall system performance status with pro-active service indications, alarms for malfunctions and safety shutdowns.
- C601.23.3 Each compressor shall be provided with PLC based control panel with man machine interface (MMI) for monitoring of the working of the compressor unit. It shall include necessary monitoring devices and safety devices. The control panel is equipped with a micro-processor with storage of proactive maintenance operations and display of information like total operating time in hours, actual on load time in hours, time before oil/oil filter/air filter/oil separator change. In the event of an error, the display shall be one of the following messages: high temperature/low oil pressure/overload etc.
- C601.23.4 The general equipment shall include the following:
- automatic start-up and shutdown mechanism,

- air pressure gauge,
- air temperature gauge,
- oil reservoir pressure gauge,
- output pressure gauge,
- emergency shutdown button,
- Identification plate with the following information:
 - type, capacity and serial number of compressor,
 - type, capacity and serial number of motor.

C601.23.5 All electrical and electronic control, regulation and other items shall be contained in a dust-tight cabinet conforming to IP 55, part of the compressor package. It shall be designed such that inspections, repairs and general maintenance are on the front panel after opening the doors.

C601.24 Pressure Reducing Sets for Compressed Air

C601.24.1 Set shall comprise a moisture separator, with trapped drain, stop valve, strainer with blow down provision, inlet pressure gauge, pressure reducing valve, stop valve, and safety relief valve with drain line to low level. An outlet pressure gauge shall be provided one meter downstream of the downstream connection of the by-pass pipe.

C601.24.2 The complete assembly shall have a full bore by-pass pipe with globe valve.

C601.24.3 The pressure reducing valve shall be supplied with filtered compressed air for operation, through a regulator.

C601.24.4 A valve pressure control pipe shall be installed between the pressure reducing valve and the low pressure side close to the pressure gauge.

C601.25 Installation General

C601.25.1 Unless specifically stated to the contrary, fabrication and assembly shall conform to ASME B31.1 for all piping of the air system. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Install piping straight and true to bear evenly on hangers and supports. Inspect piping before placing into position. Do not bury or conceal piping until it has been inspected, tested, and approved. Except where specifically shown otherwise, piping shall run plumb and straight and parallel to walls. Tubing extracted joints shall not be permitted.

C601.25.2 Piping shall not be permitted in Electrical Rooms and stairwells.

C601.25.3 Piping and other apparatus shall not be installed in such a manner so as to interfere with the full swing of doors, movement of personnel and equipment, lighting, windows, and access to other piping, conduit and equipment.

- C601.25.4 Install aboveground pressurized piping to permit draining of all sections of each piping systems without traps. Pitch piping back to system low points.[Provide manual drain valves at all piping low points.] Provide automatic drain traps where indicated and/or specified to drain condensate during operation and when the compressor stops. Compressed air piping shall be free of unnecessary pockets and pitched approximately 3 inches per 100 feet (one mm per 400 mm) in the direction of flow to low points. Where pipes must be sloped so that condensate flows in opposite direction to air flow, slope 6 inches per 100 feet (one mm per 200 mm) or greater. Install branches at top of a main to prevent carryover of condensate and foreign matter.
- C601.25.5 Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected.
- C601.25.6 Make provisions for pipe expansion and contraction with suitable anchors and offsets, expansion joints, or expansion loops. Install piping to allow freedom of movement in all planes without imposing undue stress on any section of the main piping, branch piping, equipment and structure. Piping connected to equipment shall be installed to provide flexibility for vibration. Adequately support and anchor piping so that strain from weight of piping is not imposed on the equipment.
- C601.25.7 The installation shall be neat and tidy, with accurate spacing between pipes, valves and joints, whether running in straight routes or turning through bends.
- C601.25.8 Particular care shall be taken that all pipework is erected and secured truly parallel with the building structure, clear of obstructions, preserving headroom and keeping passageways clear and that all vertical drops are plumb.
- C601.25.9 No bends or curves in any pipe shall be made so as to diminish the passage or alter the internal diameter of the pipe.
- C601.25.10 All pipes shall be fitted clear of the floor to permit cleaning beneath the pipes. Where possible, a 125 mm clearance shall be provided between the underside of the pipe and the finished level of the floor and in no case shall the pipe be less than 100 mm clear of the floor.
- C601.25.11 Site welding shall be applied with pipe work unrestrained and each joint hydraulically tested at 1.5 times working pressure plus 350 kPa for 60 minutes without loss of pressure. Working pressure to be considered as 862 kPa.
- C601.25.12 All pipe runs when buried underground shall be tested and Approved before being covered.
- C601.25.13 Where it is not possible to install the pipework with setting out dimensions as shown on the Drawings, minor deviations will be allowed, subject to prior Approval.
- C601.25.14 Where pipes pass through walls and floors, steel pipe sleeves shall be provided to allow free axial movement of the pipes. Sleeves passing through walls shall be of sufficient length to fully enclose the pipe, from one side of the finished wall to the other side. Sleeves passing through floors shall protrude at least 50 mm above and below the finished floor and soffit to enclose the pipe.
- C601.25.15 Where pipes pass through water-containing chambers, puddle flanges of Approved design shall be provided.

- C601.25.16 All pipe installations shall be provided with removable sections to facilitate pipe-cleaning operations.
- C601.25.17 Pipework shall rest freely upon supports and be carefully aligned prior to final connection.
- C601.25.18 All pipes on straight runs shall be lined up with facilities for pipes to be rotated for the process of welding joints to avoid welding from the bottom as far as possible.
- C601.25.19 During storage, all pipes shall have end covers fitted to prevent the ingress of any unwanted particles or waste.
- C601.25.20 During installation, all open ends of pipes shall be blanked off with blank flanges or pipe caps. These shall be removed only immediately prior to connecting to adjacent sections. As soon as pipes have been installed, all open ends shall be covered to prevent entrance of materials that would obstruct the pipes. Covers shall be left in place until removal is necessary for completion of the installation.
- C601.25.21 The Employer reserves the right to reject any material deemed to be unsuitable for installation and such material shall be removed from the Site and be replaced with Approved material at no extra cost to the Employer.
- C601.25.22 All Bolts, studs, nuts and washers shall be made of free machining quality stainless steel to BS 1449: Part 2 grade 304, S16 used for any application subject to outdoor environment and corrosion-resistant type.
- C601.25.23 Steel welded fittings shall be of the same weight as the piping with which they are to be used. Long radius welded elbows shall be used at changes in the direction of the pipework. Welded tees shall be used for branches of the same size as the main pipe.
- C601.25.24 Bellow expansion joints shall be provided for expansion and contraction in the pipework and also provided where the pipes cross construction expansion joints. The expansion joints shall be capable of absorbing axial and lateral movements. Confirmation shall be obtained from the proposed expansion joint manufacturer on the suitable choice of the proposed joints.
- C601.26 Fittings
- C601.26.1 Use long radius ells where appropriate to reduce pressure drops. Pipe bends in lieu of fittings may be used for piping where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and shall be free from any appreciable flattening, wrinkling, or thinning of the pipe. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction shall not be used. Make branch connections with welding tees, except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be used.

- C601.26.2 Bending of high-pressure pipe: Prior to bending pipe for high pressure systems, submit for approval written fabrication and inspection procedures and calculations showing the required minimum wall thickness of pipe after bending. Only cold bending shall be permitted. The fabrication procedure shall indicate the required pipe wall thickness prior to bending, equipment to be used, set up and bending procedures, and inspection and acceptance criteria. Inspection shall include verification of minimum wall thickness by ultrasonic or other methods if deemed necessary by the Employer. No wrinkles or other contour irregularities will be permitted in the bent pipe. Check flattening in accordance with ASME B31.1. Include required dimensional checks in inspection procedures and acceptable values tabulated for each pipe size to be bent. Qualified personnel shall perform nondestructive examinations required in accordance with qualified procedures.
- C601.26.3 Changes in pipe size: Use reducing fittings for changes in pipe size. The use of bushings will not be permitted. In horizontal lines, 2 1/2 inch (65 mm) and larger, reducing fittings shall be of the eccentric type to maintain the bottom of the lines in the same plane.
- C601.27 Unions and Flanges
- C601.27.1 Provide unions and flanges where necessary to permit easy disconnection of piping and apparatus, and as indicated. Provide a union for each connection having a screwed-end valve.[Provide unions or flanges as indicated.][Provide unions or flanges not farther apart than 100 feet (30 meters).]Provide unions on piping 2 inch (50 mm) and smaller and provide flanges on piping 2-1/2 inch (65 mm) and larger. Install dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections.
- C601.28 Threaded Connections
- C601.28.1 Where possible use pipe with factory cut threads, otherwise cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Threads shall be smooth, clean, and full cut. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed.
- C601.28.2 Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread paste, pipe cement and oil, or PTFE powder and oil; apply only on male threads. Provide exposed ferrous pipe threads with one coat of primer applied to a minimum dry film thickness of 1.0 mil (0.03 mm).[Do not thread metal pipe into plastic piping.]
- C601.29 Flanged Connections
- C601.29.1 Flanges shall be faced true and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch (1.6 mm) thickness, full-face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR).NBR binder shall be used for hydrocarbon service.

- C601.29.2 Flanged joints in high pressure air systems: Install using calibrated torque wrenches or feeler gage methods to ensure proper gasket compression. Calibrate torque wrench immediately prior to use.
- C601.30 Welded Joints
- C601.30.1 Perform welding in accordance with qualified procedures using qualified welders and welding operators. Do not perform welding when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Employer will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members shall be in accordance with AWS D1.1/D1.1M. Mark welding and brazing detail drawings to identify the welder making the joint.
- C601.30.2 Welded joints shall be fusion welded in accordance with ASME B31.1, unless otherwise required. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.
- C601.30.3 All pipe welding shall be oxyacetylene or electric arc. High test welding rods suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall accurately match intersections. Care shall be exercised to prevent the occurrence of protruded weld metal into the pipe. All welds shall be of sound metal free from laps, cold shots, gas pockets, oxide inclusions and similar defects.
- C601.30.4 Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.
- C601.30.5 Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.
- C601.30.6 Erection: Where the temperature of the component parts being welded reaches 32 degrees F (0 degrees C) or lower, the material shall be heated to approximately 100 degrees F (38 degrees C) for a distance of 3 feet (914 mm) on each side of the weld before welding, and the weld shall be finished before the materials cool to 32 degrees F (0 degrees C).
- C601.30.7 Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with ASME B31.1.

- C601.30.8 Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.
- C601.30.9 Clearances for Welding: Provide clearances from walls, ceilings, and floors to permit the installation of joints. The clearances shall be at least 6 inches (150 mm) for pipe sizes 4 inches (100 mm) and smaller, 10 inches (250 mm) for pipe sizes over 4 inches (100 mm), and sufficient in corners. However, the specified clearances shall not waive requirements for welders to be qualified for the positions to be welded.
- C601.30.10 Butt welded joints shall be full penetration joints. Butt welded joints in systems with working pressures over 2068 kPa (gage) 300 psig shall be full penetration welds with consumable inserts or backing rings.
- C601.30.11 Cleaning for Welding: Surfaces to be welded shall be free from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth and free from defects which might affect proper welding. Clean each layer of weld metal thoroughly by wire brushing, grinding, or chipping prior to inspection or deposition of additional weld metal.
- C601.30.12 Welding of Valves: Disassemble valves subject to damage from heat during welding and reassemble after installation. Open valves two or three turns off the seat when not subject to heat damage during; do not backseat valve.
- C601.31 Valves
- C601.31.1 Install valves in conformance with ASME B31.1 at the locations indicated and elsewhere as required for the proper functioning of the system.
- C601.31.2 Gate Valves: Install gate valves with the stems above the horizontal position.
- C601.31.3 Globe Valves: Install globe valves so that the pressure will be below the disk when valve is closed. Install globe valves with the stems vertical.
- C601.31.4 Pressure-Reducing Valves: Provide compressed air entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two isolation valves and with a globe or angle bypass valve and bypass pipe. Provide a bypass around a reducing valve of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure reducing valve unit with an indicating gage to show the reduced pressure, and a safety valve on the lower pressure side. These requirements do not apply to small pressure regulating valves used to adjust pressure for pneumatic equipment.
- C601.32 Pressure Gauges
- C601.32.1 Connect pressure gauges to main piping through an isolation valve with provision for bleed-off. Isolation valve shall be slow-opening needle type for medium pressure and high-pressure air systems, and shall be a ball valve for low pressure air systems. Provide snubber or equalizer in pressure gage installations on upstream side of the isolation valve. Mount gage branches vertically on top of air lines, equipment or accessories to prevent condensate and dirt from entering gauges.
- C601.33 Strainers

- C601.33.1 Provide strainers with meshes suitable for the services where indicated, or where dirt may interfere with the proper operation of valve parts, orifices, or moving parts of equipment.
- C601.34 Cleaning Procedures
- C601.34.1 Precautions shall be taken to avoid introducing foreign matter such as welding beads and slag or dirt into the piping system.
- C601.34.2 Following fabrication and installation, all piping of 150 mm and smaller shall be cleaned by flushing with clean water, run to waste, until thoroughly free of all dirt, oil and cuttings. Generally, each size of pipe shall be flushed separately before being joined with larger size piping.
- C601.34.3 Piping of 200 mm and larger shall be cleaned by pulling through a steel brush for the entire length of each pipe size, followed by fibre brush or swabs. Brushes and swabs shall be slightly larger than the inside diameter of pipe being cleaned.
- C601.34.4 All cleaning operations shall be continuous throughout the piping system, except at joints required for final jointing of various sections of cleaned piping. After cleaning and until final joints are made, the end of sections of piping shall be tightly sealed off to prevent any dirt, water and other foreign matter from entering the pipes.
- C601.34.5 Keep the interior and ends of new piping and existing piping affected by the work thoroughly cleaned of water and foreign matter. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Before jointing and erection of piping or tubing, thoroughly clean interior of pipe, tube, and components. Loosen scale and other foreign matter by rapping sharply and expel by wire brush and swab. Blow out both pipe and tubing and components with compressed air at 100 psig (690 kPa (gauge)) or more. Maintain cleanliness by closure of pipe/tube openings with caps or plugs. Before making final terminal connections, blow out complete system with compressed air at 100 psig (690 kPa (gauge)) or more. Remove foreign matter from exterior surfaces of piping, tubing, and surrounding areas.
- C601.35 Supports General
- C601.35.1 Unless otherwise specified or indicated, all brackets, stays, frames, fixed and roller supports and hangers necessary to carry and support all pipes and valves shall be provided.
- C601.35.2 Structural steel required for proper installation shall be provided. All pipe supports shall be steel, adjustable for height and prime coated with antirust paint.
- C601.35.3 Supports shall only be attached to structural framing members. Where supports are required between structural framing members, a suitable intermediate metal framing shall be provided.
- C601.35.4 Piping shall be supported independently from all equipment so that equipment is not stressed by the weight of the pipe or expansion.
- C601.35.5 Valves or other heavy items of pipework equipment shall be fitted as near as practicable to a point of support or fitted with their own supports.

- C601.35.6 Supports shall be located to ensure that pipework branches or fittings are not restrained by the support during expansion or contraction of the pipework service.
- C601.35.7 Contact of dissimilar materials shall be avoided. Steel piping shall have steel supporting member actually in contact with the pipe. Pipes shall be supported on either side of changes of direction and pipeline mounted equipment.
- C601.35.8 Vertical piping shall be guided or supported in the centre of each riser with approved steel brackets to prevent swaying, sagging, vibration and resonance. Strain that causes lines to snake or buckle between supports or anchors shall be avoided.
- C601.35.9 Where piping is subject to a vertical movement due to thermal expansion of 3 mm or more, hangers shall be of variable spring design. Variation of hanger force during operation shall range between 85 % and 120 % of the actual load.
- C601.35.10 Pipes fixed to walls or floors both vertically and horizontally shall be supported by brackets fixed to walls or supported from the floor.
- C601.35.11 All pipes in ducts shall rest on rollers and chairs, or hangers and be suitably arranged and supported to allow for expansion and contraction.
- C601.35.12 Pipe work supports and hangers shall be generally to BS 3974:Part 1 & 2. Details of all supports, hangers and accessories shall be submitted for Approval before installation.
- C601.35.13 In general, all supports, hangers, anchors and fixing accessories shall be hot-dipped galvanized.
- C601.35.14 Design of the hangers shall be compatible with pipe or tubing to be supported.
- C601.35.15 The supports shall be of sound construction and shall be adequate for the weight to be carried and shall permit free expansion and good appearance and also permit piping runs to be readily dismantled where appropriate.
- C601.35.16 Support spacing. Unless otherwise specified, pipe supports shall be provided at intervals in accordance with the following table:
- C601.36 For Steel Pipes

Size of Pipe(mm)	Maximum Intervals for Vertical Runs (m)	Maximum Intervals for Horizontal Runs (m)
15	2.5	1.8
20-25	3.0	2.5
32	3.0	2.7
40-50	3.6	3.0
65-80	4.5	3.6
100	4.5	4

Size of Pipe(mm)	Maximum Intervals for Vertical Runs (m)	Maximum Intervals for Horizontal Runs (m)
150 & above	5.5	4.5

C601.36.1 Also for each length of pipe minimum 2 supports should be provided.

C601.37 Hanger Rods

C601.37.1 Hanger rods of galvanized mild steel threaded and fitted with two removable nuts at each end for positioning rod and hanger and locking each in place shall be provided.

C601.37.2 Unless otherwise specified, hanger rods shall be of the following sizes:-

Size of Pipe (mm)	Single Rod Dia (mm)	Double Rod Dia (mm)
15 to 50, inclusive	10	10
65 and 80	13	10
100 and 125	15	13
150	20	15
200, 250 and 300	22	20

C601.37.3 Secure hangers from metallic inserts cast into concrete. When these inserts are not available, attachment by anchor bolts to be placed with fast setting high strength grout shall be used.

C601.37.4 Hanger shall be placed close to the point of change of direction of a pipe in either a horizontal or vertical plane.

C601.37.5 Supports and hangers for pipe shall be placed as close as possible to joints. When hangers or supports are not within 300 mm of a branch line fitting, additional hangers or supports shall be provided.

- C601.38 Inspection
- C601.38.1 All welds shall be inspected visually and non-destructively by the Employer. The Employer reserves the right to order at random the examination of 2 % of the number of the welded joints for ultrasonic test by an independent firm nominated and paid by the Contractor. Should any one of the above welds prove faulty in materials or workmanship, further test of welds will be ordered up to a total of 4 % of the welded joints. If the number of welds failing the tests within the above 4 %, it is sufficient to suggest that an operative is not consistent in standard, the Employer may order any number of that welds to be removed and rectified at no extra cost to the Employer.
- C601.38.2 Certification on the qualification of each welder in accordance with BS EN 287: Part 1 shall be submitted.
- C601.39 Commissioning and Testing
- C601.39.1 The low pressure compressed air system shall be subject to testing as per ASME B31.3.
- C601.39.2 Headers in the copes are to be blanked at the flange to the branch line supplying air to the header prior to the testing. Drain and balance lines shall be isolated in such a way as to exclude their isolation valves.
- C601.39.3 Following hydrostatic testing, the test fluid can be drained, subject to the approval of the Employer, via drain points. The piping system must be allowed to dry under atmospheric conditions and then purged with compressed air.
- C601.39.4 Following commissioning, leakage from the piping system shall be measured using the method outlined in section 15.2 of IS 6206. Work shall only be considered complete once losses of no more than 1% of the low-pressure compressed air system's permanent compressor capacity have been demonstrated to the satisfaction.
- C601.40 Hydrostatic and Leak Tightness Tests
- C601.40.1 Preliminary Preparation: Remove or isolate from the system the compressor, air dryer, filters, instruments, and equipment which would be damaged by water during hydrostatic tests and reinstall after successful completion of tests.
- C601.41 Performance of Hydrostatic Tests
- C601.41.1 Hydrostatically test piping systems in accordance with ASME B31.1. Vent or flush air from the piping system. Pressurize system for 10 minutes with water at one and one-half times the indicated design working pressure, then reduce to design working pressure and check for leaks and weeps. Use [distilled] [fresh, clean potable] water.

- C601.41.2 Compressed Air Leak Tightness Test: After satisfactory completion of hydrostatic pressure test, blow systems dry with clean, oil-free compressed air, and test with clean, dry air at the indicated design working pressure. Brush joints with soapy water solution to check for leaks. Install a calibrated test pressure gage in piping system to observe any loss in pressure. Maintain required test pressure for 6 straight hours. Pressure drop, corrected for temperature change, shall not be over 5 percent of indicated design working pressure.
- C601.41.3 Air Compressor Performance Tests: Field tests require use of the actual compressor drive motor. Complete performance test shall be run at maximum load, rated load, at point of unload but prior to unload, and unloaded condition. Data shall be recorded listing [as applicable]:
- Air flow, inlet pressure and temperature, humidity; discharge pressure and temperature.
 - Intercooler water flows, temperatures, and pressures.
 - Aftercooler water flow, temperatures, and pressures.
 - Bypass cooler water flow, temperatures, and pressures.
 - Lube oil cooling water flow, temperatures, and pressures.
 - Lube oil flow, pressures, and temperature.
 - Cooling water pump flow, pressures, and motor amperage.
 - [Cooling tower] [Closed circuit cooler] air flow, water and air temperatures, water pressure, and motor amperage.
 - Electrical load in volts and amperes for compressor motor (loaded and unloaded), prelube oil pump motor, and compressor auxiliaries.
 - Intake filter pressure differential (clean).
 - Start-up sequence, alarm signals and automatic system shutdown.
 - Test compressor intake and discharge for conformance to CGA G-7.1.
 - Compressor discharge shall show no increase in contaminants.
- C601.41.4 Sound Level Tests: Sound level tests shall be conducted concurrently. Broad Band "A" scale readings and Octave Band readings shall be taken and recorded at the same positions as on the factory testing. Maximum permissible level shall be 84 decibels one horizontal meter from the compressor and 5 feet (1.5 meters) above the floor, with unit in operation and all other significant equipment not required for test within the same building bay shutdown at the same location previously described. A background noise correction to 60 decibels is permissible.

C601.42 Operation

C601.42.1 When not in use cope point connections should be covered using blank flanges (DN 50) or threaded end caps of approximate size (DN 32 and DN 25).

C601.43 Interface Requirements

C601.43.1 The Contractor shall be responsible to ensure that the various E&M systems are properly interfaced and integrated with that of civil and marine works.

C700 TELEPHONE SYSTEM

C701 INTRODUCTION

- C701.1 The design shall be in accordance with the basic requirements described in the Tender Document and the best current Engineering practice, together with the following general design requirements:
- C701.2 The essence of design should be safety, simplicity and reliability in order to give long continuous service with high economy and low maintenance cost. Particular attention should be paid to internal and external access to the electrical equipment in order to facilitate inspection, cleaning and maintenance.
- C701.3 All equipment shall be designed to minimize the risk of fire and any damage which may be caused in the event of fire.
- C701.4 Care shall be taken so that materials and equipment will be the standard Catalogued products of manufacturers regularly engaged in the manufacturer of such products and will be of the latest standard designs that conform to the specification requirements. Design shall also be based on similar type of equipment supplied from one manufacturer, utilizing interchangeable parts, wherever practicable.
- C701.5 The design shall comply with relevant codes and regulations listed.
- C701.6 All apparatus, equipment and works shall be so designed that they provide satisfactory service and without any harmful effects for prolonged and continuous periods in the worst climatic conditions.
- C701.7 The reference design ambient temperature for all electrical equipment shall be taken as 50°C and appropriate derating factors should be considered for equipment as applicable.
- C701.8 Suitable derating shall be applied based on published data against the most severe conditions encountered in the site, by reducing the permissible temperature rise above the ambient level.
- C701.9 The location of the Telephone instruments shall be decided in consultation with the Employer.
- C701.10 Main EPABX
- C701.10.1 The proposed EPABX shall be 100% Non Blocking, Electronic, ISDN native. The topology shall be totally distributed so as to support and configure the Remote Units flexibly as per the changing and evolving requirements on Optical Fiber as well as copper cable.
- C701.10.2 The system shall be based on High Speed, dual core Pentium CPU and with at least 256 MB RAM. It shall be equipped with Duplication of complete Control section (viz. CPU, Signalling circuits, Tone generators, Memory, Hard Disk, RS232 ports, DTMF resources, conference circuits and other essential circuits) and common Power Supply & Ringer section in 100% Hot Standby mode. The system shall enable automatic changeover in case of failure in any of these without disrupting the existing calls in progress. The Operating system software shall be Unix based.

- C701.10.3 The system shall have RISC processor, RAM capacity of the system explicitly mentioned. It shall also specify the different control system elements duplicated in the offered system.
- C701.10.4 EPABX system shall be equipped with Ethernet port (30/100 Base T) and shall have provision to connect a TCP/IP LAN for management and metering application, which shall facilitate system management from any LAN node without using modems.
- C701.10.5 It shall be equipped with storage devices to save the data, as well as software necessary for its operation. For security reasons, these devices shall be of Flash ROM type, easy to duplicate and shall not cause any disturbance to the system. The Contractor shall specify whether information concerning variable data (forwarding, screenings) is automatically saved in real time, so that if the system goes down and comes up for any reason it doesn't lose data integrity.
- C701.10.6 The EPABX shall have all the following types of Interfaces:
- Analogue Interface to PSTN lines
 - Interface to Leased Lines
 - Paging System Interface
 - Interface to VSAT Equipment
 - BR and PR interface to Public ISDN Network
 - Digital Interface for DID
 - IP FOR VoIP & Data transfer

C702 EXTENSIONS

C702.1 Analogue Extensions

C702.1.1 The system shall be compatible with both Pulse & Tone Dialling Instruments. All instruments shall be Digital and shall have an Alphabetic Keyboard with "Dial by Name" facility from the central database of the PABX system and a user-friendly operation of the PBX internal services and of the services provided by the ISDN trunk. These terminals, as well as lower-range terminals shall be equipped with keys, which can be directly programmed by the user. The keys enable the user to change several functions (for example: call forwarding code + external number, etc.)- An option shall allow the number of keys on certain terminals to be extended. It is desired that all programming information on digital sets to be centralized and saved in the PBX to enable simple replacement.

C702.1.2 The Digital telephone sets with Display panels and Dynamic Soft keys as a part of this display panel shall be quoted. These shall be equipped with Text Messaging facility. The digital telephones shall have keys along with LCD display with associated icons / LEDs.

C702.2 Attendant Console (Operator)

C702.2.1 The operator console shall have the following features:

C702.2.2 The attendant shall provide call presentation, chaining process, call-back shall be entirely managed by the PBX. However, it shall be possible to put certain calls on individual hold on keys that have been reserved to that effect. The capacity of the various queues shall have to be unlimited. The information displayed on the terminal shall have to be explicit enough to facilitate unambiguous call handling and shall give maximum details about the communication (normal call, urgent call, queue status, name of the internal called-party, status of the telephone set etc.).

C702.2.3 An add on unit with attendant console shall be provided to enable single touch dialling and to supervise the status of certain extensions and trunks. A minimum of 48 terminals shall be supervised.

C702.2.4 The operator shall be able to modify the call answer mode from his/her attendant console. In "automatic answer", calls must be presented and connected without any intervention from the operator.

C702.2.5 To facilitate the operation of attendant consoles, operators shall be able, whatever their communication position (direct call, transfer), to call internal and external circuits according to surname, first name or initials. To assist searches, the system shall be equipped with a spelling and phonetic approximation utility program. User-friendliness being a requirement, the user shall access the service via an alphanumeric keyboard, either integrated or external to the attendant console. The Contractor shall describe in detail the access modes and the number of subscribers serviced.

C702.2.6 The system's telephone application shall enable the operator on transfer call status to send a text message to a selected internal subscriber. The operator shall have the choice between sending the message immediately onto the display panel of the subscriber if his/her line is engaged, or sending it to a text mailbox linked to the terminal, whether the latter is free or busy. This service shall only be provided if the internal subscriber's terminal is compatible with the service (digital terminals with text messaging feature). To facilitate the operation of this service, the operator shall have the choice between several types of messages:

- Pre-programmed messages to answer most common cases (example: call back the switchboard, a visitor is waiting for you in reception etc.),
- pre-programmed messages to be completed (example: call back number XYZ),
- free messages to be composed entirely by the operator.

C702.2.7 The Contractor shall describe clearly all the characteristics of the service and the size of messages, which can be sent in the various communication positions.

- C702.2.8 The operator can freely modify the operating mode of the attendant console and answer calls either in hands-free with the amplifier or with the telephone handset or headphones. When using the latter, the user can operate the amplifier with volume adjust.
- C702.2.9 The operator shall be able to modify the melody and the ringing volume of the attendant console.
- C702.2.10 The operator shall have the possibility to use servers controlled by Q23 coded frequencies.
- C702.2.11 There must be a simple procedure to withdraw an attendant console from the group and switch it into a "night service" position. The status of his/her terminal should be clearly indicated to the operator. Calls shall be forwarded to a particular station or a group distributed within the premises.
- C702.2.12 Then the attendant consoles that are present do not answer calls, the system should, after a time delay, automatically switch to "night service" mode. Calls must be routed towards dedicated stations, the status of the installation shall be clearly indicated to the operators and a simple procedure should enable return to normal situation.
- C702.2.13 Incoming calls on Specific trunks shall be possible to route to a particular operator or extension.
- C702.2.14 Attendant consoles enable the user to manage some operation parameters of the system, in particular the following points:
- create, change or delete a subscriber's attributes,
 - manage service classes (automatic dialling and call transfer etc.)
 - manage the external abbreviated dialling.
- C702.2.15 All of these operations shall have to be protected by a password programmable by the head administrator.
- C702.3 Telephone Features
- C702.3.1 The following features shall be available without restriction to all the subscribers or freely programmable:
- Routing of an external bundle on a group or individual user,
 - Calling an attendant console,
 - External call barring,
 - Local calls,
 - Simultaneous 6 party Conference
 - Consult a pending call,
 - Broker's call
 - Recording and transmission of external numbers
 - Transit function,
 - Bundles of external lines,

- Call pick-up,
- Call pick-up: group,
- Put on hold,
- Abbreviated external numbers - Minimum 200 numbers,
- Directory database in the system - minimum 1000 numbers,
- Call parking,
- Direct Outgoing Dialling (DOD),
- Direct Outgoing Dialling per cost center,
- Direct seizure of external line,
- Dedicated incoming station,
- Dedicated outgoing station,
- Station with direct routing to another station, to an abbreviated number, to an attendant console,
- Station with delayed routing,
- Protection against intrusion,
- Automatic call-back to a busy or free station
- Appointment call-back,
- Storing last dialled number,
- Last number redial,
- Call forwarding - no answer, busy, no answer/busy, fixed
- External call forwarding
- Remote call forwarding
- Night answering service,
- Call diversion on ringing,
- Moving service - without any intervention by the maintenance people, subscriber must be able to move to a new location and by dialing codes at the new locations, he should retain his existing number.
- Padlock with password protection
- Substitution -to temporarily avail all the features of the subscriber extensions at another extension.
- PIN dialling - Each extension should have a PIN dialling, through which one could make calls from a different extension and the metering must be made to the subscriber's extension.
- Call ID on Analogue Extension

C702.4 Push Button Telephones

- Feather touch push buttons for quick and sure dialing.
- Memory storage, upto 22 digits for purposes of redialing.
- Facility for redialing the last number called by pressing therepeat
- push button just once.
- Ringing facility with adjustable volume.
- Digital pulses during dialing to be muted to eliminate harsh sounds.
- Compatible with P&T network.
- Built in automatic gain control.

C702.5 Specifications

1. System voltage :48V DC + 10 %
2. Pulse Rate :10PPS
3. Break make rates :66:33/60:40
4. Inter-digit pause :800m secs. (minimum)
5. Loop resistance from the exchange : 1 K ohms (maximum)

C702.5.1 The push button telephones must confirm to CCITT standards.

C702.5.2 The telephone offered shall be approved by the TRO for interface with P&T network. A copy of the certificate shall be enclosed.

C702.6 Additional Features

C702.6.1 The following Additional Features shall be built-in the System :

C702.7 Multi Line Digital Stations

C702.7.1 This function shall enable a user to simultaneously establish, from a station answering only one number, several outgoing or incoming communications. Only one communication is active at a given time, the other engaged communications being on hold; the user shall be clearly informed of the status of the pending communications.

C702.7.2 Each key on the station can be allocated to a different call number, hence allowing differentiation of the calls. Contractor to mention how many multiline numbers can be programmed on one digital set.

C702.8 Multiple Keys and Number Stations

C702.8.1 Combining the two previous functions, each directory number can have several keys. The Contractor shall specify the number of manageable keys per station, a minimum of 6 keys which can be allocated to the multiple key / multiple number function would be desirable.

C702.9 Executive/Secretary Sets

- Call Filtering - Certain calls on the Executive set should be programmed to reach directly, whereas all other calls shall be routed to the secretary.
- Real time diversion without picking-up the call,

C702.10 Additional Features

C702.10.1 The system shall be equipped with in-built music-on-hold device that shall have a capacity of 10-15 seconds and shall have good acoustic quality.

C702.10.2 The proposed telecommunications system shall be equipped with 4 port P.C. "automatic attendant" feature allowing, the reception of external calls and offering to direct them interactively to a pre-defined service or subscriber. The interactive dialogue shall be based on DTMF. Errors (incorrect codes) shall be handled by an information message and return to the current message. If no Q23 code is received, the call shall automatically flow over to a dedicated number, after a pre-set delay.

C702.10.3 CT1 shall support for following computer environment- Digital, IBM, Microsoft, etc.

C702.10.4 The physical interfaces supported shall be on V.24, RS232, SO, TCP/IP. Both first party and third party CTI solutions shall be supported.

C702.10.5 The EPABX shall have in-built interface for IP functionalities. The Contractor shall enclose the detailed implementation schematic for VoIP and shall quote price for 10 VoIP users. It shall support the following:

- Connection of a server via LAN-LAN router and LAN-WAN (ISDN)
- Voice over IP and Frame Relay.

C702.11 Main distribution frame

C702.11.1 The main distribution frame for Field side and Exchange side shall be housed in a metal cabinet and shall be equipped with Krone modules for 200 Pair terminations. An Intermediate Distribution Frame shall also be provided for 200 Pairs with Over-voltage and over-current protection for all the Trunk lines. The interconnection between MDF and IDF shall be done using Jumper Wire. The Contractor shall do all termination of cables and jumpering at the MDF.

C800 CLOSED CIRCUIT TELEVISION (CCTV) NETWORK

C801 INTRODUCTION

C801.1 This section describes the general requirements for the CCTV Network.

C801.1.1 High Resolution colour CCD cameras will be installed to ensure surveillance through the monitoring of the project areas, as well as create a tamperproof record for post event analysis. The system shall facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.

C801.1.2 The system shall provide inter-operability of hardware, operating system, software, networking, printing, database connectivity, reporting, and communication protocols. The system shall be designed to allow future expansion.

C801.2 CCTV Particular Requirements

C801.2.1 The main CCTV server cabinet shall be located in the control room or as directed by Employer.

C801.2.2 A 12c single mode fibre optic cable shall be routed from the Main CCTV Cabinet to one CCTV camera equipment node located within the area. From this CCTV camera equipment node a 4c fibre optic cable shall be routed to the two other equipment nodes.

C801.2.3 CCTV camera equipment nodes shall be fed from power supply unit in the CCTV junction box (which is powered LV 240V, 50Hz from generator) or directly from main supply. Sufficient numbers of CCTV cameras shall be installed in the area to provide complete coverage.

C801.2.4 The control room shall have a workstation terminal with one 48" monitor, an operator console and printer. CCTV pan, tilt and zoom control will be made available. Sequence viewing and split screen functionality shall be provided.

C801.3 General Specifications

C801.3.1 The optimum solution shall be provided with the following features:

- Commonality of equipment throughout
- Reduced requirement for spares holding

C801.3.2 The CCTV Cameras shall be designed for the following:

- Weather resistant, industrial-grade design, suitable for use in marine environment.
- Suitable for extremely low light levels
- Cameras shall automatically self-adjust for day/night operation.
- Camera housings shall have an ingress protection rating of IP66 or better, in accordance with the requirements of IS/IEC60529.

- C801.3.3 All cameras shall be remote control pan, tilt and zoon (PTZ) type.
- C801.3.4 The CCTV system cameras and PTZ controls shall be IP based. Video and data signals are to be encoded via an NVR (Network Video Recorder) using TCP/IP for system transmission. All video cameras shall provide high quality real time video (4CIF, 25/30 fps) for both recording and display. The composite video signals are to be encoded in MPEG-4 AVC/H.264 format and stored into the (NVR) mirrored hard drive array for 31 days before being automatically discarded in a first in first out (FIFO)format.
- C801.3.5 NVR shall be included in the server cabinet. Detailed equipment drawings to be developed at detail design.
- C801.3.6 From a manually initiated command, camera footage will be marked for long-term storage on a separate drive. This separate drive will not automatically discard any video. The system will also be able to archive the video traffic to different media such as DVD, USB memory stick, external hard drive, etc.
- C801.3.7 The CCTV Control System shall be a server based modular system based on a window's PC platform. CCTV network general requirements shall include, but not be limited to the following;
- The system will transmit and receive inH.264/MPEG-4.
 - The proposed CCTV system shall be an open standard based integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.
 - The system shall be capable of accepting video signals from CCD colour cameras, process them for viewing on workstations/monitors locally, simultaneously record all the cameras, and be capable of being remotely accessed and be compressed using MPEG-4 or greater standard. Joystick controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras.
 - The NVR/Camera Server can be embedded type or local server based. However, the NVR/Camera Server software shall run on common off the shelf available servers. Each NVR/Camera Server shall be able to be expanded to cover the stated number of cameras, plus the requirement for 20% future expansion.
 - Network Video Recorder shall offer both video stream management and video stream storage management. The recording frame rate & resolution, in respect of each individual camera shall be system administrator programmable.
 - The system shall ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes and shall contain all required time, date and positional data.

- The system shall provide sufficient storage of all the camera recordings for a period of 31 days, or more, @ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras (including extended future capacity of camera system).
- Each monitoring/control station shall have a one 24"monitor and printer as a minimum.
- All the control equipment e.g. servers, NVR/Camera Server, encoders etc. shall be provided in suitable tamperproof cabinets (i.e. lockable).
- Contractor shall include for all associated bracketing, clamps, masts and any other types of hardware required. They are to be supplied and installed, including any required civil works, by the Contractor. No extra cost will be paid for any miscellaneous items required to complete any part of the CCTV system.
- The image recording resolution / definition and general performance aspects of the CCTV system shall comply with all local authority requirements including police / judicial requirements for acceptance as evidence in civil or criminal proceedings.

C801.4 Main CCTV Equipment Cabinet

C801.4.1 The complete CCTV system shall be provided as identified within the project documents which shall include, but not be limited to the following;

C801.5 CCTV System Servers

C801.5.1 Dual redundant CCTV system servers shall be provided for system resilience and security; these shall be located within a dedicated secure CCTV system rack.

C801.6 Network Video Recorders-

C801.6.1 Dual redundant network video recorders shall be provided for system resilience and security, these shall be located within a dedicated secure CCTV system rack.

- Rack mounting: 19"Rackmounted.
- Storage media: RAID Hard disk.
- Capacity: 31 recording days.

C801.7 CCTV System Software / Licenses

C801.7.1 The Contractor shall supply, install, test / commission and configure a DVMS (Digital Video Management System) from a reputable international CCTV system Contractor. The DVMS shall have a spare capacity of 20% for future expansion.

- C801.8 CCTV Equipment Cabinet Node
- C801.8.1 CCTV Equipment Cabinet nodes shall be provided local to the CCTV high mast to interface with the adjacent cameras. The cabinet nodes shall be of compact dimensions, modular design, easily upgradable, allow for 20% future capacity, and allow for a simplistic hook up to the overall CCTV infrastructure.
- C801.8.2 The CCTV Equipment Cabinet nodes shall be IP67 in accordance with the requirements of IS/IEC 60529. Nodes shall be tamperproof (i.e. lockable), made up of 18 SWG galvanised sheet steel, and complete with rain/sun shade.
- C801.9 CCTV Control Console
- C801.9.1 The CCTV Console array shall be suitable for simultaneously displaying CCTV images for each of the cameras installed. All CCTV consoles shall be provided complete with all power supply and signal connection cables and components. CCTV monitors shall be supplied and installed complete with all fixings / fixtures and mounting brackets and shall be installed to prevent glare or reflection from artificial or natural lighting sources.
- C801.9.2 The size of the room, position of the operator and lighting arrangement shall be taking into consideration when selecting the type of screen.
- C801.9.3 PTZ cameras shall have present position setting functionality, with default Home position field of view to be determined during detail design.
- C801.10 External IP CCTV Camera
- C801.10.1 All CCTV camera enclosures shall as follows;
- Type: External IP CCTV Station
 - Material: ABS or Sheet Steel - Submit proposals.
 - Vandal resistant fasteners: Required.
 - Ingress protection IS/IEC 60529: IP67or IP666(min).
 - Integral heater: Required.
 - Sun shield: Required.
 - Mechanical IK10
- C801.10.2 Camera enclosures shall be suitable for continued service and shall afford full protection to the CCTV cameras / lenses under the local climatic and environmental conditions.
- C801.10.3 Camera enclosures shall provide cowls / hoods for protection against glare from sunlight / flood-lights to prevent the occurrence of glare and degradation of CCTV images. CCTV camera enclosures shall not deteriorate due to exposure to UV light (ultra-violet) or other environmental factors.
- C801.10.4 Cameras shall be supplied complete with all fixtures / fittings, enclosures as necessary which shall be suitable for continued service under the local climatic and environmental conditions.

- C801.10.5 PTZ units shall be suitable for continued service under the local climatic and environmental conditions and shall have the following minimum performance requirements.
- Pan angle: 5° -350°.
 - Tiltangle: -20° -90°.
- C801.11 Speed control: Variable
- Panspeed: 0.6 -45°/s.
 - Tiltspeed: 1 -10°/s.
- C801.12 CCTV Camera Mounting Arrangements
- C801.12.1 CCTV Cameras shall be located on dedicated columns at all locations, these shall comprise galvanised steel modular towers supplied complete with all foundations, holding down bolts, electrical equipment enclosures, and camera mounting brackets, anti-climb accessories and removable mast winch mechanisms etc.
- C801.12.2 Co-ordination with the civil works design and incorporation of all associated cable ducts for LV power and communications signal cables.
- C801.12.3 All CCTV camera masts and all associated fittings / fixtures and accessories shall be designed, manufactured and installed in order to achieve a minimum 20 year design life under local climatic / environmental conditions, due consideration shall be given to the harsh conditions and saline atmosphere.
- C801.12.4 All CCTV camera masts shall be provided with a suitable earth electrode located within a concrete earth inspection pit located adjacent to the column. Earth electrodes shall comprise 19mm x 2,400mm copper bonded steel earth rods installed in accordance with BS EN 62305-3 generally, and shall be connected to the column using 70mm² Cu/PVC earth conductor. The camera column shall have the following minimum design requirements:
- Material: Steel.
 - Finish: Galvanized to BS EN ISO1461.
 - Base: Bolted flange.
 - Tiltover facility: Required.
 - Anti-climb guards: Required.
 - Lighting bracket: Required.
 - Fixings: Stainless steel grade A2 to BS EN ISO 3506-1 and-2.

C900 RAIL MOUNTED MOBILE TOWER CRANE

C901 SCOPE OF WORK

C901.1 General

- C901.1.1 The equipment specified herein shall be designed and built for Machine parts/equipment Handling on a regular basis, at Naval Base at Kochi for Indian Navy.
- C901.1.2 The equipment and materials covered by this specification are subject to the referenced attachments. This tenderer shall be responsible for and governed by all the requirements of this specification and Conditions of Contract, which shall be part of this document.
- C901.1.3 The Scope of Work is Engineering, design, manufacture, Supply, delivery to site, installation, testing and commissioning of 2 numbers of 50T capacity rail mounted tower type ELL crane suitable for handling machine parts and equipment's for maintenance of vessels, related operations up to handing over with initial fill of fuel, lubricants and other necessary consumables.
- C901.1.4 The required cranes shall be electric powered rail-mounted type for handling machine parts/equipment as specified. The duty requirements, capacities, overall dimensions and functional parameters shall be as described within this specification and the attached drawings, which form part thereof.
- C901.1.5 All equipment shall be complete and shall include everything necessary to provide fully commissioned and operational machines that will perform as specified. Overall dimensions (boundary dimensions) and functional requirements as shown on the drawing(s) and/or specified shall be adhered to meet the operational requirement.
- C901.1.6 All works incidental to the above including additions, substitutions and modifications, if any.
- C901.1.7 Tenders based on International sources shall have due consideration for maximizing components, which have service / support in India. Tenderers shall list out the availability of such facilities and the details of such arrangements in the event of award.
- C901.1.8 Tension relieving Drum (TRD) shall be provided in the berth pit (in middle of Crane travel length) including cable support system inside the pit for each Crane. Stainless Steel cable loop In loop out Box also to be provided in the pit for taking supply to each crane.
- C901.1.9 One number of Personal Elevator to be Supplied and installed in the Rail mounted Crane.
- C901.1.10 Fire Alarm system to be considered in the Electrical room, Machinery house and operator cabin of the Rail mounted crane.
- C901.1.11 Lightning arrester to be provided in the mast of the tower crane and down conductor shall run from the top of the crane to the earth shoe. Insulators to be provided at every 1.5mtr interval to support the down/Horizontal conductors.

C901.1.12 Special tools which are required for maintenance of the crane & spares as mentioned in the specification also to be supplied with the crane.

C901.2 Work Included

C901.2.1 Work shall include, but not be limited to the following:

- (a) All technical information required by others, for the design and installation of civil, structural, mechanical and electrical works at the machine interfaces, and in accordance with the Documentation Schedule.
- (b) Management, coordination, planning of the work at all locations of the work within India including occupational health and safety, quality control, cost control, design, manufacture, delivery, inspection, installation, testing, commissioning and training on operation and maintenance.
- (c) Supply, erection and delivery of all temporary structures, tools, rigging, erection machinery, temporary power for erection, testing, adequate site lighting, temporary water supplies, transport logistics, etc.
- (d) Supply of all Employer and labour for design, manufacture, delivery, installation, testing and commissioning of equipment, including transportation as required, housing, security, temporary sanitation and safety requirements, up to handing-over of equipment.
- (e) All consumable materials including filters, lubricants, hydraulic fluids, battery fluids, electrical fuse, temporary loads up to equipment handing-over.
- (f) Clean-up at site of all debris and temporary structures on a daily basis and final clean-up at handing-over.
- (g) All electrical safety requirements during erection/installation, testing and commissioning, including adequate earthing of erection equipment and machines.
- (h) Proper safe storage of all equipment and materials delivered at site, in areas designated by the Employer in line with customs regulations if applicable.
- (i) Manuals for installation, operation, maintenance spares, along with drawings as required.
- (j) Training of Employer's personnel on operation and maintenance.
- (k) Supply of spare parts as required up to Performance Guarantee Test and Taking-over and for two years operation after Taking-over.

C901.3 Work Not Included

- C901.3.1 Ships, cargo (general cargo) will be supplied by others for testing and commissioning machines in accordance with the mutually agreed program.
- C901.4 Attached Drawings
- C901.4.1 The sections and plans give information regarding jetty geometry. The arrangements shown are not fixed but indicate desirable characteristics.
- C901.5 Related and other Contracts
- C901.5.1 The Contractor(s) shall be responsible for coordination with the contractors of other contracts being carried out simultaneously, if any
- C901.5.2 The details of work, if any (pertaining to the scope of the Contract), to be carried out by others for installation of the items to be supplied by this Contractor(s) shall be furnished along with the tender.
- C901.5.3 This Contractor shall inspect and report to the Employer about the works executed by other agencies, if any, which has direct bearing on the performance of his equipment. Failure to do the same will be construed as acceptance of other contractors' work.
- C901.6 Contractor's Plant, Equipment, Labour, Personnel, Fuel and Consumables
- C901.6.1 The Contractor shall provide and mobilize all necessary plant, equipment and labour for the completion of the works. He shall provide all necessary maintenance facilities for the plant and equipment which shall not be demobilized and removed from site before the completion of the works without the written permission of NAVY/CoPT – Engineer-in-charge. All counter weights filling works are under the scope of the contractor.
- C901.6.2 The Contractor shall ensure that all work is undertaken by trained and competent personnel under the supervision of responsible persons, experienced in the particular aspect of the works being undertaken. Site engineers and supervisors shall be deputed as per requirements.
- C901.6.3 The Contractor shall arrange for required supervisory staff on Site as and when required.
- C901.6.4 Material handling equipments, Gas, Water, electricity and Compressed air shall be arranged by the crane supplier/contractor and necessary approvals shall be obtained from local statutory authorities and NAVY/CoPT as applicable. Space for providing site office, assembly, erection shall be provided by NAVY/CoPT, free of cost as per the availability.
- C901.6.5 Contractor/supplier has to make his own arrangements for unloading the crane parts as well as for erection purpose.
- C901.7 Safety, Health and Welfare; Protection, Life-Saving Etc.
- C901.7.1 The Contractor shall fully comply with all relevant Indian health and safety legislation in force at the date of tender submission.
- C901.7.2 The Contractor shall fully comply with the General HSE guidelines promulgated by / Co. PT /NAVY/CoPT which.. All precautions and permits not limited to the following shall be complied with in connection with the erection, testing and commissioning of the crane.

- a) Hot work permit
 - b) Permit for work at height
 - c) Permit for Scaffolding
 - d) Electrical shut down permit
- C901.7.3 The Contractor shall give prompt and due consideration to any matters to which NAVY/CoPT may find it necessary to call attention, for the purpose of ensuring compliance with NAVY/CoPT requirements.
- C901.7.4 The Contractor shall provide handrails, scaffolding, and take such other safety precautions as are consistent with normal good safety practice. Warning signs shall be displayed at relevant locations in English and Hindi.
- C901.7.5 Site operatives shall be fully conversant with the use of safety equipment. The Contractor shall provide all necessary personal protective equipment (PPE) to his workforce and that of his sub-contractors. This shall include, but shall not be limited to; safety boots, hard hats, gloves, lifejackets, eye protection, ear defenders, high visibility vests, harnesses etc.
- C901.7.6 All safety rules to be observed while working on live electrical system or installation as stipulated in the Factories & Boilers Act, Indian Electricity Rules, Central Electricity Authority Rules & Regulations and as per NAVY/CoPT standards. Any approvals required from NAVY/CoPT and statutory authorities shall be obtained in this regard. Work permits/ electrical power shutdown permits shall be obtained from NAVY/CoPT wherever required.
- C901.7.7 In the event of any casualty or accident occurring on the site during the execution of the works, the Contractor shall comply with all existing legal obligations requiring him to give notice of the casualty or accident to any person or persons and shall notify as soon as possible both the Employer's safety and medical departments and NAVY/CoPT of any such occurrence.
- C901.7.8 Contractors shall ensure release of payments to all personnel deployed by them for the project as per government rules and NAVY/CoPT Guidelines.
- C901.8 Advance Notification of All Operations
- C901.8.1 In addition to his general obligations under the Contract, full and complete notice shall be given by the Contractor of all operations to be carried out on the site. Such notice shall be provided in sufficient time for NAVY/CoPT/ TPIA to make all necessary arrangements for inspection and checking. Such inspection and checking shall not relieve in any way the obligations of the Contractor under the Contract.
- C901.8.2 Work on holidays/ Sundays/off-working hours planned by contractor is to be intimated to NAVY/CoPT at least one day in advance.
- C901.9 Regulations of Statutory Authorities and Customs
- C901.9.1 Without limiting his obligations under the general conditions of the contract, the Contractor shall be responsible for meeting obligations of all statutory authorities, including but not limited to, local representatives, the Indian Electricity rules and Act, Central Electricity Authority rules and regulations, Fire Insurance Regulations, Kerala State Electricity Board, Cochin Port Trust.

- C901.9.2 Should any of the statutory authorities request an inspection of the installation, equipment or the final works, the Contractor shall co-ordinate with NAVY/CoPT / TPIA in carrying out such inspection. Any modification suggested by the authorities shall be carried out by the Contractor, on the advice of NAVY/CoPT / TPIA at no additional cost.
- C901.9.3 The Contractor shall comply with all regulations imposed by the Customs authorities in respect of the passage of all imported Contractor's Equipment, Plant, Materials and vehicles and personnel through Customs barriers (Land and Water).
- C901.9.4 Crane manufacturer shall understand and comply the following Indian Acts / Rules scrupulously and NAVY/CoPT hereby firmly and solemnly informs and declare that any noncompliance or issue comes in this connection or as a dispute on these Acts / Rules is fully under the risk and cost of crane manufacturer during the entire period of this project either at crane manufacturers works or at NAVY/CoPT site or during transportation and NAVY/CoPT is therefore no way responsible or at risk. Relevant Act /Rules are:
- Contract Labour (Regulation and Abolition Act)
 - Employees Compensation Act
 - ESI Act
 - EPF Act
 - Minimum Wages Act
 - Payment of Gratuity act
 - Any other acts/rules/norms stipulated by Govt. Authority during the period of contract.
- C901.10 Contractor's Working Area
- C901.10.1 The crane supplier shall undertake fabrication of the structures at supplier's works or elsewhere (in view of constraints of space for the same within NAVY/CoPT premises) complying to all terms and conditions stipulated herein with this RFQ including all annexure, transporting and delivering the same at NAVY/CoPT project site, assembling, erection and commissioning at site.
- C901.10.2 If the equipment is delivered fully assembled, the Contractor is kindly requested to consider delivery of crane within a nominated window to minimize disruption to other site activities. In this regard, contractor has to study the NAVY/CoPT layout and take all necessary precautions so that maximum loading limit insisted for the jetty civil structure is not exceeded at any point of transfer of crane from the vessel to the track rails. In case of any untoward incident involving damage to Jetty, it is the responsibility of the crane supplier to rectify the damages without any cost to NAVY/CoPT.
- C901.10.3 The Contractor is responsible in ensuring that any equipment used on site for the final assembly work& erection, such as mobile cranes, is compatible with the underlying civil structure.

- C901.10.4 Before work is allowed to commence on site, the Contractor is required to demonstrate adequate provision has been made to prevent permanent damage to the site. The Contractor is required to make good any damage caused during the assembly, commissioning and testing phases of the equipment on site.
- C901.10.5 The Contractor is responsible for all costs involved in movement of the cranes across site and onto their working rails. All temporary works in connection with installation of crane shall be under the scope of crane supplier.
- C901.10.6 Hot work shall only be carried out on site with the permission of NAVY/CoPT. Suitable PPEs (Personal Protective Equipments) are to be used.

C902 GENERAL SPECIFICATIONS

C902.1 Interfaces

- C902.1.1 The successful contractor, within 21 days of the award, shall furnish the design loads and typical drawings to the Employer for design and construction/supply by others of the interfaces.

C902.2 Rail Track tolerances

- C902.2.1 Long travel rails will be supplied and installed by others within the following tolerances and equipment shall be suitable to operate under these tolerances.

Level along each rail over complete length	+15 mm
Level along each rail over 50 m length	+10 mm
Level across rails	+10 mm
Gauge of rail	+10 mm
Alignment of each rail	+15 mm

- C902.2.2 The typical rail profile and foundation configurations are shown in the tender drawings. The equipment shall be designed to operate normally within the rail and track tolerances given and also shall conform to FEM standards.

- C902.2.3 Rail top will be flush with top of berth.

C902.3 Stability and Safety

- C902.3.1 The equipment shall be stable in all conditions, free on wheels.

- C902.3.2 The slewing superstructure consisting of jib, counterweight mast, connecting structural elements shall comprise a completely stable self-supporting structure seated on the undercarriage.

- C902.3.3 The equipment design shall ensure stability for all conditions including vessel through faulty operation or by failure of the luffing motion or any other circumstances. Stability for other conditions shall meet the minimum requirement of European Federation Standard (FEM).
- C902.4 Anchoring Devices
- C902.4.1 Anchor units shall be provided for holding the equipment during storm condition having wind velocity up to 39 m/sec as an additional safety. It shall be suitable for fixing manually to anchor points provided at the parking place. Anchor points shall be of rapid fixing type by an operator and shall be suitable to the design and construction details of the jetty. Limit switches shall be provided for electrically interlocking the anchoring device with the long travel drives to ensure that the long travel motors cannot be started with anchoring device activated. Vertical drop-in type holding down device will be preferred at the berth. Boom of the crane shall be anchored separately at the jetty if necessary. The Tenderer shall confirm the arrangement, locations and the forces considered for the respective supply in the bid. The successful tenderer shall reconfirm the forces along with relevant details within 30 days of award of the contract.
- C902.5 Anemometer and Aviation Warning Lamp
- C902.5.1 A wind anemometer shall be provided at the top of the fixed structure. It shall continuously monitor wind velocity and shall be interlocked with the equipment controls and annunciations so that all operations except long travel shall cease when the steady wind velocity exceeds an adjustable set limit. Annunciation shall be prior to stopping of equipment and it shall be possible to move the equipment to parking areas for parking after the annunciation up to the 18 m/sec wind velocity.
- C902.5.2 LED type aviation warning lamp shall be provided at the highest point of the crane, in parking position.
- C902.6 Operating Safety
- C902.6.1 Crane shall be designed as per Indian / International safety standards and regulations.
- C902.7 Safety and Identification Signs
- C902.7.1 Safety and Identification signs shall be placed on all equipment and work areas. All equipment and work areas shall have signs for:
- (a) Hearing protection
 - (b) Warning the “equipment may start without noise”;
 - (c) High voltage
 - (d) Eye protection
 - (e) Other safety signs as required by local codes.
 - (f) Safety and Identification signs as per manufacturer’s standard are acceptable in case the cranes are in accordance with the European Machinery Directive 2006/42/EC

(g) Provision of suitable lightning arrestors

(h) Design Features for Maintenance

- C902.7.2 Safe and direct access shall be provided to all drives, auxiliaries, electrical equipment, including limit switches and junction boxes, lubricating points and all other areas of the structure where switches, indicators or pivots of any type are installed. Ready access shall also be available between parts of the machine which move relative to one another.
- C902.7.3 Platform, walkways, stairs, ladders and handrails shall comply with code requirements. EN 13586 – Cranes: Access. In case the cranes are a serial product, Contractor's standard design is acceptable.
- C902.7.4 All external structural steel surfaces intended for access shall be treated with proprietary approved non-slip surface. All other surfaces intended for pedestrian access shall consist of hot dip galvanized welded flat bar grating or shall be made from aluminium unless otherwise specified. Angular pattern floor plate shall not be used except in front of electrical cubicles or over structural members where spillage can be trapped by grating.
- C902.7.5 Stairways shall be of uniform slope and stair treads shall be hot dip galvanized grating or manufactured from aluminium with floor plate nosing.
- C902.7.6 The use of ladders shall be avoided and will require specific review and approval by the Employer during design.
- C902.7.7 Hand railing shall preferably be of tubular section with all joints seal welded.
- C902.7.8 Equipment and other mechanical components shall be designed throughout with special attention to accessibility permitting inspection, maintenance and renewal of parts with minimum of delay. Travelling truck wheels, pulley assemblies, etc. shall be readily removable. Wherever possible, each gear, pinion, shaft, coupling, bearing, shall be readily removable without disturbing other parts. Lubrication and hydraulic fittings shall be readily accessible. Walkways, stairs, ladders, if approved by the Employer, shall be provided for personnel carrying out inspection and maintenance. All replaceable components shall be accessible either to a maintenance hoist provided on board or to mobile cranes from ground level.

C903 EQUIPMENT DESCRIPTION

- C903.1 General
- C903.1.1 In general, the machines shall operate within the constraints and infrastructures as described herein and in the attached drawings. This shall include climatic conditions, materials handled, stability, performance expected, interfaces described and for future installations, as noted on the drawings.
- C903.1.2 The mandatory clearances and interface limitations, and machine and human safety, requirements shall be respected in all modes of operation.

- C903.1.3 Stability of all machines shall be unconditional for all operating and non-operating loads, including but not limited to; chassis and jib collisions; operating and non-operating wind; overloads; jib resting on ground / deck. All possible loading combinations shall be examined in this regard. All machines shall be stable (from over-tipping) free on rails under all conditions.
- C903.2 Cargo to be Handled
- C903.2.1 The equipment shall be for handling of general cargo, equipment, machinery etc.
- C903.2.2 Configuration of the Harbour Crane
- C903.2.3 The rail mounted Crane shall be a travelling, slewing, luffing machine conforming to the general arrangement. The crane shall be designed to operate on the jetty taking into account the ship sizes and tidal conditions. It shall be suitable for loading / discharging ships with at least 10 T load @ 50m radius at all load/ballast and tide conditions.
- C903.2.4 The harbour crane shall comprise a self-driven undercarriage (chassis) supporting a slewing superstructure with a counterweighted jib incorporating rope reeving arrangement to hoist a hook for General cargo handling. The arrangement shall permit quick attaching/detaching of the handling device.
- C903.2.5 The operator's cabins shall be ergonomic, offering a clear view of the working zones.
- C903.3 Portal Gantry
- C903.3.1 The Portal Gantry shall provide a rigid and robust structural support to minimize structural distortion and to distribute the loads to ensure well distributed corner loading. The gantry shall be a four-point, four-corner fully equalized support system. The portal gantry shall incorporate the long travel drive assemblies.
- C903.4 Speeds, Capacities, Range of Operation
- C903.4.1 The following parameters shall be adhered to in the bid. Those listed but not given here shall be supplied with the bid:

Material	General Cargo
No x Berth Rails and Rail Centres	1 x CR 100 and 10 m centres (for the equipment)
Length over buffers (max.)	22m for crane (shall be reduced to the extent possible)
Outreach from centre of crane	~50 m
Travel (long) Speed	0 – 30 m/min infinitely variable in both directions in case of electric system
Wheel Dia (min.)	630 mm (tread dia)
Distance between wheels	830 mm

Material	General Cargo
within bogies (min)	
Distance between bogies (min)	2000 mm
Long Travel (min)	(pay out point as per drawing)
Cable Length (m)	140 m
Max. Wheel Load	35 tonnes including dynamic effect (operating/storm)
Max. Corner Load	275 tonnes including dynamic effect (operating/storm)
Stability Factor (min.)	1.3 (under operating condition) 1.1 (under non-operating condition when free on wheels)
Ambient Temperature for design consideration	45°C (for mechanical components) 50°C (for electrical system)
Humidity	Varies from 23% to 100%

- C903.5 Control Philosophy
- C903.5.1 Control Cable distribution within the equipment shall be established to the relevant I/O racks and field devices as required.
- C903.5.2 Each motion of any equipment can be operated from the respective local control or a radio remote control device, bypassing the Central Control System, only in maintenance mode.
- C903.5.3 No equipment can be operated in 'maintenance mode' and the interlock features shall only be available in 'operating mode'. Only one motion at a time can be run on no load in 'maintenance mode' for testing / observation.
- C903.5.4 Switching from 'operating mode' to 'maintenance mode' shall be feasible only from the respective local control or radio remote control after obtaining permissive signal from the Central Control System.
- C903.5.5 The equipment unless specified otherwise shall have
- (a) programmable anemometer;
 - (b) safe load indicator and programmable interlock set-point;
 - (c) Crane monitoring system;

- (d) emergency switch to stop all the on-board drives and long travel/gantry area;
- (e) interlock of slewing superstructure with undercarriage travel and boom structure, if provided.
- (f) CCTV camera to be provided in Gantry area, boom area to monitor the operation from operator cabin.
- (g) Anti-Collision system to avoid the collision of crane
- (h) Infrared type or equivalent type sensors to be provided in the crane leg to sense the presence of men or material near the crane leg and shall stop the long travel operation.
- (i) UHF base station to be provided in the operator cabin and office central room. Two numbers of UHF hand set also to be supplied with each crane which shall include the license from the statutory authority.
- (j) Provision for giving auxiliary LT supply to crane from outside when crane is at ideal/ not working.
- (k) Warning siren (with flash & sound) in the four corners of the crane (i.e. Bogie)
- (l) Hydraulic Rail clamps

C904 MECHANICAL CRITERIA AND DESIGN REQUIREMENTS

C904.1 Design Criteria

- C904.1.1 The design of the equipment shall be such that ships can be berthed and de-berthed without any interference with the crane positioned on the jetty for operation / parking.
- C904.1.2 The equipment shall be capable of performing all loading / unloading operations for wind upto 18 m / sec wind velocity.
- C904.1.3 The equipment structure shall be stable, free on wheels during wind pressures corresponding to basic wind velocity of upto 24 m/sec as per IS 875 Part III.
- C904.1.4 However, anchoring device and suitable anchor points on the equipment are to be provided, as stand-by for holding the equipment during storm condition and basic wind velocity upto 39 m/sec.
- C904.1.5 Equipment shall be stable under all operating conditions including when some portion of the machine touches the ground or the ship. Stability for other conditions shall meet the minimum requirement of FEM and wind conditions specified herein.
- C904.1.6 Sufficient information and drawings showing static and dynamic loads shall be supplied to the Employer to design / verify the design and construct necessary foundation work falling under scope of others.
- C904.1.7 Common cable reeling drum for Control and Power Supply shall be provided and shall be mounted on the equipment structure.

- C904.1.8 Buffers shall be installed at both ends of each long travel track. The buffers shall be rubber/ spring operated and be designed in such a way as to ensure that the collision forces are distributed. Buffers installed on the crane structure shall be hydraulically dampened / rubber type.
- C904.1.9 All components shall be designed and constructed to operate outdoors continuously at peak loads and under climatic and ambient conditions outlined in relevant sections. When ship is at jetty, loading/unloading shall be continuous without interruptions till the ship is completely loaded / unloaded.
- C904.1.10 The cranes are designed and manufactured in accordance with the European Machinery Directive 200/42/EC and all associated relevant European Standards (EN). FEM rules and International Standards (ISO) are considered wherever possible.
- C904.1.11 Operator's cabin with all controls shall be provided at a suitable location to have an unobstructed view of the handling operation.
- C904.1.12 The crane shall be capable of unloading/loading the cargo without moving the ship.
- C904.2 Travel Drives
- C904.2.1 Long travel drives for the machine shall achieve specified speeds in all combinations of operating weather, loading conditions, and track tolerances, specified herein.
- C904.2.2 Drives shall be electric motor driven mechanical type with gear reducers shaft mounted on the driven wheels. Torque reaction shall be via flexible mounting on bogie. Reducer shall not be self-locking.
- C904.2.3 Brakes shall be separate assemblies mounted on motor or reducer high speed shaft. Brakes shall be mainly used as holding brakes. Capacity of each brake shall not be less than 150% of the full load motor torque.
- C904.2.4 At least half the wheels shall be driven.
- C904.2.5 Drive speed shall be infinitely variable in both travel directions, from 0-100% of nominal speed. This shall be accomplished with inverter duty, AC 415 V, 3 phase motors, variable voltage and frequency drives or hydraulic drive, controlled machine acceleration and deceleration shall be field adjustable. Variable Voltage Variable Frequency Drive (VVFD) shall operate in all modes necessary to accomplish dynamic braking under all wind and load operating conditions. Load sharing between multiple drive shall be done electronically.
- C904.2.6 Sustained constant speed travel shall be available and possible from 15% to 100% of nominal speed, for continuous operation.
- C904.2.7 All drive components shall be capable of withstanding loads safely from overdriven or reversing loads due to wind loads, power failures or braking.
- C904.2.8 End buffers shall have sufficient capacity to stop the equipment travelling at higher rated speed.
- C904.2.9 Rail sweeps shall be provided at the outer end of each bogie to clear the rails of any obstruction. The rail sweeps shall be vertically adjustable.

- C904.2.10 Provisions shall be made at each corner of the under carriage for jacking to permit the removal of travelling wheels/bogies. The jacks required for replacement shall be the part of supply.
- C904.2.11 Travel wheels shall be double flanged having minimum tread diameter and tread width of min. 630 mm and 40 mm more than the rail head respectively. Higher wheel dia and spacing would be preferred subject to compliance of wheel load/ corner load limitations and reduction in number of drives. Wheels shall be of forged/cast steel. The tread shall be hardened to in excess of 300 BHN and tested ultrasonically.
- C904.2.12 All wheels shall be mounted on shaft with self-aligning bearings.
- C904.2.13 Mechanical Assemblies and Components
- C904.2.14 The cranes shall be designed and manufactured in accordance with the European Machinery Directive 2006/42/EC and all associated relevant European Standards (EN) as well as FEM and ISO standards.
- C904.3 Gear (Speed) Reducers
- C904.3.1 All equipment supplied shall be of approved manufacture, unless otherwise specified. The equipment shall be the Supplier's normal design suitable for the duty specified. Replacement gears, bearings and seals shall be readily available in India or at least via the Contractor's local office in India. Reducers shall be of the helical, bevel helical or planetary gear type. Reducers shall be capable of being driven in either direction at the rated capacity without reduction of the specified design life.
- C904.3.2 Hollow shaft drives are acceptable.
- C904.3.3 All components of speed reducers shall be designed for continuous duty at maximum demand power with capacity to stop and start under fully loaded conditions. The speed reducer shall also be designed to allow back driving through the reducer to the motor.
- C904.3.4 The thermal rating for reducer operation shall be based on the lubricating oil bulk (or sump) temperature not exceeding 80°C for 45°C ambient shade air temperature and shall not be less than the installed motor power. The use of mineral oils is preferred. The use of synthetic oils shall be subject to specific approval by the Employer.
- C904.3.5 Reducer's durability service factor and strength factor shall be 1.5 and 2.5 respectively based on motor power.
- C904.3.6 All gearing shall be capable of safely withstanding not less than the full peak torque of the drive motor applied twice in direct succession. The reducer shall be capable of not less than 10 full load starts per hour. When the braking torque is applied to the high speed shaft and the braking torque exceeds the starting torque, then the braking torque shall be considered in the selection of the speed reducer.

- C904.3.7 Overhung loads generated by flywheels and/or brakes and/or fluid couplings shall not exceed the speed reducer manufacturer's recommendation. If excessive overhung load can be induced, these items shall be mounted between pedestal bearings with flexible coupling used between both the motor shaft and the reducer input shaft.
- C904.3.8 The reducer casings shall be steel fabricated or made from cast material in case this is Contractors standard design. If welded, the welding shall be oil-tight and the housing stress relieved after welding, and prior to any machining. Reducer casings shall be provided with easily removable inspection covers wherever possible to allow the reducer internals to be viewed without disturbing the drive. Reducer casings shall be provided with lifting lugs, oil filling cap, a visible oil level indicator, a side located oil drain, an air-breather and a permanent magnet plug.
- C904.3.9 Provision shall be made in the casing design for horizontal alignment of the reducer in longitudinal and transverse direction, as well as vertical adjustment. A drilled and tapped connection shall be provided for installation of a temperature transducer wherever possible. The connection shall be such that transducer oil well is covered with oil. The hole shall be plugged.
- C904.3.10 Adequate means of lubrication for all gears and bearings shall be maintained at all operating positions of the reducers. Splash lubrication using mineral oil is preferred. Where pumped lubrication is unavoidable, the pump suction shall remain submerged in the lubricant for all operating positions of the reducer.
- C904.3.11 The reducer identification plate shall specify the required oil type and quantity.
- C904.3.12 Oil sampling points shall be fitted in a suitable location to allow sampling when operating.
- C904.3.13 Bearings shall be of standard type and size readily available in India. Bearing selection and life shall be in accordance with specifications herein.
- C904.3.14 All reducer shaft seals shall be of the "labyrinth and double lip neoprene" type with provision to purge with grease. TACONITE type seals or modified TACONITE type with non-contact lip seals are preferred or approved equivalents.
- C904.3.15 It is preferred that reducers be rated with sufficient thermal capacity so that fan cooling will not be required. If fan cooling is used, then the fan impeller shall be of the split type to facilitate replacement without removal of the couplings and/or disturbing the alignment of any component in the drive. Hoist gear boxes shall be equipped with oil coolers.
- C904.4 Mechanical Brakes
- C904.4.1 Brakes shall be fail-safe and applied upon loss of electrical power. Brakes shall be spring or counterweight applied. Caliper type brakes (disc brake) shall be provided.
- C904.4.2 Electric braking system, wherever it can be justified, shall always be supplemented by mechanical braking system.
- C904.4.3 Brakes shall be equally effective in both directions of shaft rotation.

- C904.4.4 Brakes shall generally be mounted outside either on motor shaft or on high speed shaft of reducer. Integrated brakes, for instance with motor or reducer are not acceptable (Exception: cable reeling drums).
- C904.4.5 The braking torque shall be not less than 1.5 x motor full load torque.
- C904.4.6 The brakes shall be capable of dissipating, without external cooling, energy released by stopping the machine or machine assembly twice in immediate succession plus the required number of equally spaced stops per hour as would be applicable to the duty.
- C904.4.7 Braking equipment located outdoors shall be designed to operate in a highly abrasive dust laden atmosphere, and shall be high pressure hose proof.
- C904.5 Lubrication
- C904.5.1 Lubrication shall be provided for each rotating part or sliding ways that operate continuously when equipment is in operation. As far as possible centralized grease system with hand operated pumping units with reservoir having sufficient storage capacity, unless otherwise specified, shall be provided. Hand operated pumping unit as stand-by arrangement shall be quoted with each motorized unit.
- C904.5.2 Panel type centralized grease lubrication system shall include but not be limited to the following groups of machinery.
- (a) Slewing Ring
 - (b) Equalizer assembly wheel bearings and pivot pins.
 - (c) All truck axles and drive shaft bearings of all equipment;
 - (d) Hoist rope machinery.
- C904.5.3 Each of the systems shall be designed to ensure positive lubrication at every point and to supply a measured quantity of lubricant to each lubrication point whenever the pump is operated.
- C904.5.4 Each system shall be equipped with one motor operated high pressure pump (wherever the system is motorized) and all necessary components, including relief valves, vent valves, filters, pressure indicators, manifold or distributor block, etc.
- C904.5.5 All lubrication fittings, bushings, brackets, support clips, piping, etc. shall be provided for the efficient installation of each system. All fittings shall be standardized to IS 4009 or equivalent ISO standard.
- C904.5.6 Extra strong wrought steel pipes shall be used for main header lines and Bundy tubing for branch lines to individual greasing points. All pipes shall withstand 100% higher pressure than maximum applied by the pump.
- C904.5.7 Visual indicators shall register any single line blockage.
- C904.5.8 Extension of lines from header shall be maximum of 10 m.
- C904.5.9 If lubrication is required at a moving point, coupled wire braid reinforced lubricant hose shall be used.

C905 SPECIAL ASSEMBLIES AND COMPONENTS

C905.1 Operator's Control Cabin

C905.1.1 The Control Cabin to be of ergonomic, modern design with ample glassed area for optimum visibility of the working area. The Contractor shall demonstrate the visibility range from the Operator's Cabin under all operating conditions by means of 3D CAD modelling or demonstration of existing similar cabin concept.

C905.1.2 The cabins shall be manufactured from steel framing clad with painted steel sheeting inside and out. Provide heat and noise insulation and dust seals for all doors and windows. It shall also be fitted with a cable access within the floor.

C905.1.3 The minimum clear height shall be within the cabin to be 2200 mm.

C905.1.4 The windows shall be of approved tinted safety glass. The front and roof / floor windows shall be equipped with a heavy-duty window wiper and washer system. All windows shall be cleanable and replaceable from inside the cabin.

C905.1.5 Safe and easy access to the control cabin shall be provided over the full range of machine operation. An elevator shall also be provided for access to the control cabin from ground.

C905.1.6 The cabin door shall be a hinged type self-closing door with adjustable hydraulic closer and fitted with an approved type of security lock.

C905.1.7 The cabin is to be designed to maintain comfortable conditions for the Operator under all climatic operating conditions. A window / split type air-conditioner shall be provided to maintain required temperature inside.

C905.1.8 Noise level inside the cabin shall be limited to 60 dB when cabin door and other windows are closed and ventilation system is operating. Vibration inside the cabin shall be limited to such level as to ensure unhampered functioning and safety of all sensitive equipment and also as to ensure operator's comfort for continuous working.

C905.1.9 Equipment installed inside the operator's cabin shall include, but not be limited to the following:

- (a) Height and back adjustable operators chair incorporating joysticks, switches, and push buttons.
- (b) Light fittings with dimmers.
- (c) A minimum of 2 x 240 V, 5 A, 1 Ph, and 2 x 240 V, 15 A, 1 Phase General Purpose Outlets (GPO).
- (d) Telephone – 1 No., in the Operator's Cabin, communicating with two near ground level at two diagonally opposite points.
- (e) Fold down jump seat on the back wall to allow for an instructor
- (f) Operators console and monitoring interface as specified.
- (g) Battery operated mains charged Emergency Lighting to provide minimum 15 lux level in cabin and outside of cabin.

- (h) Fire Extinguisher CO2 – 2 Nos. (1 inside & 1 outside)
- (i) Handset station for Public Address – 1 No.

C905.1.10 Equipment installed outside the cabin must meet the international standards and shall include:

- (a) Electrically amplified weatherproof loudhailer.
- (b) Emergency lighting head(s), powered by inside located power pack.
- (c) Window washers and wipers.
- (d) The operator's control cabin shall provide optimum visibility of the jetty as well as the vessel hatches, deck gear and superstructure. Video monitoring of the in-hatch operation shall be enabled with jib-mounted camera and VDU/HMI in the operator's cabin and other in Machinery/control room.

C905.2 Counter Weights

C905.2.1 Counter weight, wherever provided, shall be of ordinary cast iron or concrete and shall be of such weight, size and shape as to be convenient for handling, transport and field erection purposes.

C905.3 Safety & Control Devices

C905.3.1 Limit switches, position indicators, level indicators, actuating cams and other safety and control devices shall be included but not be limited to the following operations:

- (a) Travel
 - (i) Horn or whistle to sound continuously when machines are travelling.
 - (ii) Interlock between long travel of equipment and jib in locked position for commencing long travel motion.
 - (iii) Interlock of long travel drive of equipment with skewing superstructure.
- (b) Luffing and Hoisting
 - (i) Luffing movement of jib with two over travel limit switches.
 - (ii) Hoisting motion with two over travel limit switches.
 - (iii) Rope slackening indication device in case of rope operated mechanisms.
- (c) Slewing
 - (i) In both directions of slewing motion, including two over travel limit switches (in case slewing range is less than 360°).

- (ii) Suitable protection device to prevent lifting of the ball race of slewing mechanism of the equipment under any condition.
- (d) Interlock for anchorage with long travel of outdoor duty equipment.
- (e) Wind anemometer to continuously monitor wind velocity and shall be provided with contacts to permit interlocking with equipment controls and annunciators so that operations shall cease when steady wind velocity exceeds an adjustable limit.
- (f) Interlock between brake/hydraulic coupling and motor wherever drive units have brakes/hydraulic couplings.
- (g) Interlock between hydraulic power pack and oil level indicator.

C906 STRUCTURAL DESIGN CRITERIA AND DESIGN REQUIREMENTS

C906.1 Structural Assemblies and Components

C906.1.1 Loads and amplifying coefficients shall be calculated based upon the requirements of FEM 1.001/98 Section 1 (3rd Edition) using the loads generated by the duty of the machine as given herein.

C906.1.2 This shall apply to the supporting structures and the mechanism structures of the equipment.

C906.1.3 The equipment structure shall be designed at least for the following criteria:

- (a) Class of Mechanism ... U5
- (b) State of Loading ... Q3
- (c) Group of Mechanism ... A6

C906.1.4 Other codes below shall apply for the design of structures:

- (a) EN 10025-2 Hot rolled products of structural steel
- (b) ISO 8992 Fasteners- general requirements for bolts screws, studs and nuts
- (c) ISO 4014 Hexagon head bolts
- (d) ISO 4017 Hexagon head screws
- (e) EN 1090-2 Execution of steel structures and aluminium structures
- (f) DIN 18800-7 Steel structures – Execution and constructor’s qualifications
- (g) ISO 13920-BF General tolerances for welded constructions
- (h) EN 25817 Arc-welded joints in steel; Guidance on quality levels for imperfections
- (i) EN 1998 Design of structures for earthquake resistance

- C906.2 Type of Construction
- C906.2.1 Equipment main structures shall be of welded and bolted construction. All field joints shall be of bolted assembly with high strength friction grip bolts unless approved.
- C906.2.2 Field welding will not be permitted except in very special instances and only then with the written approval of the Employer. Field welding of load carrying members, if done, shall be ultrasonically tested for acceptance. Minimum test length of welds shall be 300 mm per 1000 mm of weld length. All ultrasonic test records shall be kept in hard copy form and submitted, upon request, to the Employer.
- C906.3 Wind Loads
- C906.3.1 Wind pressure and loads [as per IS 875 (Part 3)] shall be calculated using the following values:
- (a) Normal operating wind velocity 18 m/sec at all levels
 - (b) Restricted travel wind velocity 24 m/sec at all levels (permitting travel to the storm tie down position)
 - (c) Cyclone wind velocity 39 m/sec.
- C906.3.2 These wind pressures and loads shall be used in conjunction with shape and shielding factors.
- C906.4 Floor and Walkway Loads
- C906.4.1 All floors, walkways access platforms and stairways shall be designed in accordance with FEM / DIN / EN / ISO standards for a uniform live load of 2 kPa (min) for local flooring and steel members design.
- C906.4.2 All machinery floors shall be designed for the following loads:
- C906.4.3 Machinery dead load plus a uniform live load of 2 kPa (min) for local flooring and steel member design.
- C906.5 Earthquake Loads
- C906.5.1 Earthquake effects shall be calculated in accordance with Indian Standards IS 1893 / European Standard EN 1998 / ISO 5049-1.
- C906.6 Load Combinations
- C906.6.1 The loads shall be combined in a manner to produce the maximum stress on a particular structural member. The load combinations shall be in accordance with FEM 1.001/98.
- C906.7 Considerations for Detailing
- C906.7.1 Structural design and detailing shall be such as to produce a structure of modern appearance without any pockets that will hold dust or water. The design shall minimize welded or other connections that can produce stress concentrations.

- C906.7.2 For individual member designs, a lattice type fabrication is acceptable though rolled shapes or heavy-duty tubular sections will be preferred, any built-up sections of angles or channels shall be spaced to enable easy inspection and maintenance of all surfaces. Sections shall not be connected to form battened or starred struts.
- C906.7.3 Irrespective of load carrying requirements, all welds shall be continuous and form fully sealed joints. The ends of tubular or other hollow sections shall be completely sealed.
- C906.7.4 The structure shall be designed so as to easily facilitate maintenance and painting. All non-hermetically sealed sections shall be accessible for inspection.
- C906.7.5 Access holes shall be minimized. Any detail deemed to require holes for assembly shall be shown on the shop drawings. In general access holes, where permitted, shall be left open and:
- (a) The holes shall be at least 50 mm diameter.
 - (b) For fillet welded details the fillet weld shall be returned through the hole to meet the fillet weld on the other side of the plate.
 - (c) For complete penetration weld details, care must be taken to ensure acceptable weld profiles inside the hole.
- C906.7.6 The hole shall be dressed to the same finish as for plate edges.
- C906.8 Minimum Thickness
- C906.8.1 The minimum thickness of material for main structural elements shall be as follows unless otherwise specified:
- (a) For steel fully accessible for cleaning and repainting – not less than 8 mm.
 - (b) For steel not accessible for cleaning and repainting – not less than 10 mm.
- C906.9 Materials
- C906.9.1 Weldable steels with the yield strength in the range 250 – 350 Mpa shall be used for structural components.
- C906.9.2 The main load bearing structures of the cranes are manufactured from S355J2G3 according to the European Standard EN 10025; auxiliary structures from S235.
- C906.10 Access Structures
- C906.10.1 The design and manner of support for floorings, platforms, walkways and stairs is in accordance to DIN / EN / ISO standards.
- C906.11 Connections
- C906.11.1 All connections shall withstand forces of a minimum of 50% of the member capacity or 1.1 times the applied load, whichever is greater.
- C906.11.2 Shop connections shall be welded, unless otherwise approved.

- C906.11.3 Major field connections shall be bolted, with mating bearing surfaces milled or machined with adequate tolerances to ensure contact is maintained. Joints shall be designed as pre-tensioned by means of high strength bolts or alloy steel pre-stressing bars
- C906.11.4 Field welded connections shall not be used where there is any likelihood of distortion induced by welding causing misalignment of bearings and machined surfaces.
- C906.11.5 Secondary field connections shall be designed as bolted. Secondary connections are defined as connections for conveyor deck platforms, walkways, stairs purlins and girts.
- C906.11.6 Bolted connections shall incorporate a minimum of two bolts for angles and four bolts for structural tees, universal columns, beams and channels over 150 mm deep.
- C906.11.7 Where pinned connections are employed in main joints, internal lubrication patterns and lubrication points shall be provided. Where bushings are used in pinned connections, bushings shall have internal lubrication patterns and shall be provided with the necessary wall thickness to prevent elastic and thermal distortion under load. Thin walled bushings are not acceptable.
- C906.11.8 As a minimum standard, structural bushings shall be manganese bronze, press fitted into suitable housings for pin connections.
- C906.11.9 Special spherical bearings for heavy duty application and ease of alignment may be employed for hinged boom connections or other similar applications. Provision shall be made for the ready lubrication of all such bearings.
- C906.11.10 Purpose designed low friction and lubricated for life bearings, shall be employed for pantograph mechanisms or any bearings difficult to access. In such cases bearings shall have a design factor of at least twice the normal safe working load; the design shall employ normal factors of safety based on this increased design working load. Notwithstanding that the bearings are lubricated for life, lubrication points shall be provided.
- C906.12 Residual Stresses
- C906.12.1 The effect of residual stresses in steel weldments shall be taken into account in the design. In particular, consideration shall be given to stress relieving or other heat treatment of heavy weldments in order to improve fatigue and fracture performance.

C907 ERECTION AND INSTALLATION

C907.1 General

- C907.1.1 The Contractor(s) shall prepare erection drawings, programme and list of equipment to be used for erection of each component and shall submit to the Employer for review prior to erection. The programme shall include, but not be limited to:
- (a) Sequence of erection of each machine
 - (b) Handling and Cranage

(c) Details of Temporary Bracing and Guying

- C907.1.2 Erection drawings should show size and location of all members, give complete locations and details for setting anchor bolts, indicating elevations of all bases, extent of bolted or welded connections and all details necessary for erection.
- C907.1.3 While planning the crane requirement, site conditions and access roads thereto shall be taken into account. Crane and spreader beams shall be positioned under load points as necessary. The supplier shall take into account the load carrying capacity of the jetty. Drawings of jetty will be given to the tenderer.
- C907.1.4 Prior to commencement of erection, the Contractor shall examine the existing works of other Contractors on which this work is dependent and report to the Employer or his representative anything that may affect his work.
- C907.1.5 Planning of erection procedures including provision of necessary guying / temporary bracing shall be carried out to ensure safety and trueness of the structure under all conditions of wind and erection loads occurring during construction period.
- C907.1.6 Alignment and fitting of machinery shall be carried out by skilled and experienced machinery fitters.
- C907.1.7 It shall be the responsibility of the Contractor(s) to provide steel or other temporary supports during erection.
- C907.2 Improper Fits and Adjustments
- C907.2.1 All tolerances/adjustments shall conform to any international standards/codes/practices. Wherever applicable it shall conform to FEM / DIN Standards.
- C907.2.2 It shall be the responsibility of the Contractor(s) to provide all lubricants/hydraulic fluids/fuel oil for start-up and up to and the completion of commissioning tests and shall include services for application of such material as and where required.
- C907.2.3 The sequence of erection of the structure shall be such that no member is stressed beyond what it is designed for.
- C907.2.4 It shall be the responsibility of this Contractor(s) to co-ordinate with the other Contractors regarding allocation of time, space, erection equipment and other facilities. This shall be done with the approval of the Employer.
- C907.2.5 The Contractor(s) shall strictly adhere to the approved erection schedule. Advancing of the erection schedule may be approved by the Employer provided the activities that are inter-related to / dependent on other contractors' work are not strained.
- C907.2.6 Selection of the type of equipment to be used for erection at the jetty, or elsewhere, shall be based on the consideration that the design live loads are as follows:

- (a) Jetty: 3 T/m²

(b) General: Standard Class AA (wheeled vehicle) as per IRC Code of Practice for Road Bridges.

C907.2.7 If any special methods such as complete shop assembly and transportation to site in assembled condition are thought of, the same shall be supported by details and sketches and shall be submitted along with the bid. Also, the type of trial runs to be conducted prior to despatch shall be brought out.

C908 SURFACE TREATMENT AND PROTECTIVE COATINGS

C908.1 General

C908.1.1 All structural steel components need to be protected permanently and effectively against any formation of rust thus avoiding weakening of the cross-sections. Protection against corrosion shall be achieved by painting. The paint coating is effective only if it adheres completely and permanently to the steel surfaces and if the paint resists quick wear.

C908.2 Preparation of Surfaces for Painting

C908.2.1 All surfaces of components to be painted shall be thoroughly cleaned of all foreign matters adhering to the steel surface to Swedish Standard / ISO 8501-1 specification Sa 2 ^{1/2} by means of blasting with sand or shot. Use of scraper wire brush and pig hammer is acceptable wherever blasting with sand is not possible due to lack of access.

C908.2.2 Any removal of rust adherent to steel surfaces by means of chemical solvent is prohibited.

C908.2.3 Subsequent to the removal of rust, oil and grease deposits shall be removed with chemical solvents. Wet surfaces shall be dried and painting shall generally be done immediately after cleaning.

C908.2.4 Welding areas shall not be painted until after the completion of welding operations.

C908.2.5 However, wherever welding has to be carried out after erection at site, the shop coat of paint shall be removed thoroughly unless specifically permitted because of use of appropriate electrodes and paints, before welding and the adjoining steel surface including welding area shall be repainted after proper cleaning as specified herein.

C908.2.6 In case of interrupted welding seams, the front points shall be thoroughly cleaned from rust.

C908.3 Painting

C908.3.1 Two coats of epoxy base zinc rich primer (92% zinc on dry film) shall be applied by airless spray. The dry film thickness of two coats shall be 60 microns minimum.

C908.3.2 Internal surfaces of box girders shall also be painted with two coats of zinc rich primer (two coats of 60 micron total film thickness)

- C908.3.3 After the application of primer, all surfaces shall receive two coats of coal tar epoxy or any other high build epoxy compatible with the primer. The finish paint shall be applied by airless spray to establish an enduring protection of the prime coat. It shall be resistant to atmospheric heat, reflect heat and rays and withstand mechanical stresses without crumbling. The total dry film thickness for these 2 coats shall be 200 microns minimum. The colours for the finishing coats shall be as approved by the Employer.
- C908.3.4 Total dry film thickness for the system to be 260 microns minimum.
- C908.3.5 For steel work intended to be painted only at site, a primary coat of Red Oxide Zinc Chromate shall be given at the shop before despatch as a temporary protection.
- C908.3.6 In case the cranes are of serial production and Contractor has a good experience and references for his standard painting system and painting procedures in similar crane application in marine and saline environments, the Contractor's standard painting system will be acceptable even in case it deviates from the above detail specifications.

C909 ELECTRICAL ASSEMBLIES AND COMPONENTS

- C909.1 General
- C909.1.1 The specifications and standards cited herein are, for reference. Original Equipment manufacturers (OEM's) specification / makes / standards other than below are acceptable.
- C909.2 Power Supplies
- C909.2.1 The interface for all machine power shall be the cable reel connection to the yard supply at 415V, 3 Ph, 50 Hz. Power supply tolerance at this point of connection will generally be as follows:
- (a) Voltage variation +10%
 - (b) Frequency variation +1% steady and 2% transient
 - (c) Phase Imbalance 2.5%
 - (d) Combined Voltage & Frequency +10%
- C909.3 Utilization Voltages
- C909.3.1 Unless otherwise specified, utilization voltages for all machines shall be as follows; and shall be provided by equipment included with the machines:
- (a) AC Motors 415V, AC, 3 Ph and 230 V, AC, 1 Ph, 50 Hz
 - (b) Lighting 230 V, AC, 1 Ph, 50 Hz
- C909.3.2 Voltage drops between 415V switchgear and end devices such as motors shall not exceed 3%.
- C909.4 Codes and Standards
- C909.4.1 Crane shall be designed as per EN & ISO standards.
- C909.5 Enclosure Ratings and Designs

- C909.5.1 The environment in which the machines will be operating will be extreme in terms of temperature, humidity, corrosion and dust.
- C909.5.2 Ambient temperature for the design and manufacture of enclosures and equipment shall be taken as 50°C.
- C909.5.3 Particular attention shall be given to the mounting of the switchboards and control equipment to ensure that they are not subjected to vibration.
- C909.5.4 Physical access to all equipment shall be possible without requiring the removal of mechanical or other electrical equipment and shall be in accordance with the local Indian regulations for access clearance.
- C909.5.5 The switchboard and control equipment housings, which shall be located within on-board protected enclosures such as switch rooms and operator's cabins, shall be manufactured to IP55 with heat dissipating elements shall be of integrated IP42 enclosures. All electrical equipment located outdoors shall have an enclosure rating of IP56. All outside JB shall be of Stainless steel.
- C909.6 Lighting
- C909.6.1 The lighting system on the machines shall consist of the following:
- C909.6.2 Minimum levels shall be as given below:

Area	Lux Level	At	Type of Luminaire
Machinery Rooms	150	Floor	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink
Operator's Cabin	150	Desk	LED Panel with ultra-modern recess mounting luminaire
Electrical Room	150	Floor	LED Panel with ultra-modern recess mounting luminaire
Platforms, Stairs and Walkways	100	Floor	Well glass LED Fittings
Working areas for machines	100	Floor	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink

- C909.6.3 All luminaries shall be suitable for industrial duty and provided with IP 66 housings for outdoor enclosures and IP 55 for indoor enclosures.

- C909.6.4 Luminaire lamps shall generally be protected from physical damage by suitable "lexan" covers or metal cages or both. Trolley mounted luminaries shall always have both kinds of physical protection.
- C909.6.5 All fittings shall be weatherproof and able to withstand direct hosing.
- C909.6.6 Lamp life rating shall be a minimum of 50,000 hours.
- C909.7 Emergency Lighting
- C909.7.1 Emergency lighting bulkhead luminaries shall be supplied to ensure a safe exit in the case of power failure.
- C909.7.2 Enclosures shall be of weather and dust-proof construction and consist of cast aluminum body with polycarbonate diffuser, 1 x 13 W LED tube, integral transistorized control gear, charger and 24 V batteries. Each shall be connected to the 240 V supply system and shall automatically switch to the battery in case of power supply failure.
- C909.7.3 Additional Lighting Requirements
- C909.7.3.1 Provide LED Type aviation warning lamps at highest accessible point of Mobile Crane.
- C909.8 AC Motors
- C909.8.1 All AC motors shall be TEFC or TENV (unless specified otherwise), induction type suitable for operation on 415V, 3 Ph, 50 Hz. Motors smaller than 1.5 HP may be supplied for 240 V, 1 Ph operation.
- C909.8.2 Motors supplied for operation with variable voltage and frequency drives shall be designed specifically for inverter duty with minimum 1100 V rated windings. Compliance with NEMA, MG-1, Part 31 standard or equal shall apply.
- C909.8.3 Motors supplied shall operate successfully with conditions of voltage and frequency tolerances specified herein and modified by variable frequency drives as required.
- C909.8.4 Windings of all motors shall have Class 'F' insulation with Temperature rise max. 75 Degree over ambient 50°C by resistance method. The windings shall be tropicalized.
- C909.8.5 In case of use of VVFC drives suitable additional de-rating factors shall be considered for all motors on account of harmonic loss, low speed operation.
- C909.8.6 All motors except main drive motors (IP 55) shall have IP 56 degree of protection for indoor and outdoor duty.
- C909.8.7 All MV motors shall have phase segregated terminal box. Main and neutral terminal boxes shall be interchangeable.
- C909.8.8 All motors shall be suitable for bi-directional.
- C909.8.9 Motors rated 37 kW and above shall be provided with anti-condensation space heaters suitable for 240 V, 1 Ph, 50 Hz supply.
- C909.8.10 Motors rated below 30 kW shall be suitable for connecting 24 V, AC supply to its stator winding for winding heating during motors idle time.

- C909.8.11 Separate terminal boxes shall be provided for space heaters.
- C909.8.12 All motor shall be provided with adequate grease lubricated ball or roller bearings as required. Bearings shall be housed in dust-tight bearing end shields and shall be provided with easily accessible grease nipples and valves for ejecting excess grease.
- C909.8.13 All motors rated 55 kW to 132 kW shall be fitted with thermistor winding protection and motors rated above 132 kW shall have RTD's and BTD's.
- C909.8.14 In addition to the manufacturer's standard nameplates, a metal tag for motor identification number (6 digits, 12 mm high) shall be permanently fixed to each motor.
- C909.8.15 Special, low rotor inertia motors that are required for high-speed hoist and Trolley duty, shall generally comply with all requirements specified herein for normal duty motors.
- C909.8.16 Voltage drop during motor starting shall be limited to 10%.
- C909.9 Trailing Cable
- C909.9.1 The cable shall be composite (preferred) flexible with power, earth cores and pairs for control and communication. Power cores shall consist of 3.5 Nos. power tinned copper conductor with three earth cores in the interstices, specifically designed for motor driven cable reel application. For the control core in the composite trailing cable fiber optic is preferred. The cable shall be suitable for use on 1100V power system. The trailing cable shall be suitable for 90 deg. C. conductor temperature and shall be Ethylene propylene rubber (EPR) insulated and polychloroprene sheathed taped with rubber proofed cotton tape, braided with 0.3 mm, 0.4 mm ATC wire with 0.57 filling factor. The cable shall be suitably de-rated according to number of layers and dimensions of the cable reeling drum. The length of cable provided shall be adequate for uninterrupted travel of the machine and four dead turns on the cable drum.
- C909.9.2 The control cores shall contain screened twisted pairs or fiber optic control and communication use shall form part of this cable. Control cores are intended to transmit/receive control signals to/from central control room via a plant data bus and shall be adequate to meet the system requirement. The requirements of construction, insulation, etc. as stated for power cable shall be applicable for control cable as well. The length of composite cable provided shall be adequate for uninterrupted travel of the machine and four dead turns on cable drum.
- C909.9.3 The trailing cables shall be in accordance with VDE 0250/ equivalent.
- C909.10 Supply, Installation, Testing And Commissioning of Crane Trailing Cable Protection System :

- C909.10.1 The cable Protection system shall a proven system have a continuous semi-flexible belt, fabricated from rubber with inlaid steel reinforcement, which lies over channel cast in the quay. The size of the trench shall be constructed in such a way that 2 Nos crane trailing cables shall to be accommodated in the trench in the berth being under construction. The same shall be reverted/ firmly fixed to the quay surface along one edge, while the other remains free to be raised by a cable guide and belt lifting device fitted to the crane. Steel reinforcement has been incorporated to retain flexibility of the belt in all direction, except transversely to the channel axis, so that the cable inside the channel is totally protected from vehicles crossing the track and from objects falling into the cable duct.
- C909.10.2 It is possible to convert a hinged plate system both for conductor bars or cables reel supply to this more flexible covering system. The main components of the system shall consist of:
- Stainless steel rivets
 - Pre-drilled fixing strip
 - Steel reinforcement rubber cover
 - Steel channel profile
- C909.10.3 A complete system consists of the following components:
- Either standard or super reinforced belt in rolls of approx. 50m, with joints at their ends.
 - Stainless steel channel AISI 316, 1.5mm thick, 2 meter long sections.
 - Hot dip galvanized 30x8mm fixing strips, with 13 pre-drilled holes per meter, in 2 meter long sections.
 - Stainless steel or nickel copper rivets, 13 per meter.
 - Earthing copper strips with screws and nuts.
 - Anti-filling and alignment system with expanded polystyrene.
 - Alignment brackets for channel sections.
 - Shall capable for the vehicles passage.
 - Channels, fixing rivets, etc are available on request.
- C909.10.4 The channel shall be customized as per concrete channel under construction. Total quantity is as per the crane travel length including all the accessories. Works includes supply, installation, testing and commissioning charges at site and responsibility includes the technical support, supervision regarding the fixing of item with the existing civil contractor at site completely. The fixing of same shall be done along with the civil work of the berth under construction. Full responsibility for fixing the channel with suitable fixing materials, cement concrete for height adjustment etc. comes under the scope.
- C909.10.5 Make: Covatec, Conductix Wampfler, Auxema Stemmann/ Mepserve.
- C909.11 Motor Control Centre
- C909.11.1 The motor control Centre shall be designed, built, rated and tested in accordance with the applicable publications and standards. MCC shall be factory assembled, and tested before delivery to the site.

(a) **Ratings**

- (i) The rated insulation voltage of the main circuit: 1100 V AC.
- (ii) The rated working voltage of the main circuit: 415 V AC 3 phase, 4 wire.
- (iii) The rated voltage of the control circuit: 110V AC, 1 phase, 2 wire common control transformer with tapings + 2 1/2 % and + 5%.

(b) **Construction**

- (i) The MCC shall be made out of cold rolled annealed sheet steel metal (2.5 mm thick for load bearing members and 1.6 mm thick for doors and covers). The MCC shall be totally enclosed free standing single/double front and fixed type design, except incomers and bus couplers which shall be draw out type. The enclosure shall conform to IP 55 degree of protection. Cable entry shall be from bottom. Undrilled gland plates and required quantity of double compression GI gland shall be provided. Operable height for any switch/meter shall be within 300 mm - 1800 mm.

(c) **Bus Bars**

- (i) Bus bars shall be of high conductivity copper suitably sized for the specified current ratings.
- (ii) The buses shall be so supported and braced as to be capable of safely withstanding the maximum thermal and magnetic stresses corresponding to the short circuit currents specified.
- (iii) The main horizontal bus bars shall be located at the top in a separate chamber extending the entire length of the same. Bus bar chambers shall have separately screwed cover. All bus bars, links, etc., shall be adequately shrouded to prevent accidental contact. Cut edges of hylam supports shall be varnished.
- (iv) Power shall be distributed to each module or compartment by a set of vertical bus bars. The vertical bus bars shall run behind the modules and individual modules shall be fed from the vertical bus bars through copper link connections, which shall be adequately shrouded. It shall be possible to easily remove the shroud for inspection and maintenance.
- (v) Bus supports shall be arc resistant, non-tracking, made out of low absorption synthetic resin bonded insulation or equivalent having high insulation strength and high creepage surface.
- (vi) Appropriate colour codes shall be used to identify the various phases of the bus bars and the neutral.

(d) **Components**

- (i) Incomer unit of MCC shall have manually operated, fixed type ACB (moulded/non-moulded type) complete with magnetic short circuit and thermal O/L releases, indicating lamps (3 phases R-Y-B), instrument transformers and required relay and metering outfits. The incomer shall also be provided with under-voltage relays/relay with delayed tripping facility. ACB feeders shall be provided with microprocessor-based O/L, S/C and E/F released.
- (ii) Outgoing starter module unit of MCC shall have MCCB with magnetic short circuit release, contactors, thermal overload relays, ON-OFF-test push buttons, ON-OFF-Overload trip-indication lamps, ammeter with suppressed range scale to read starting current (up to 11kW drives direct reading ammeter and 11 kW and above CT operated ammeter with selector switch to read current in all the three phases). Motor feeder, including and above 75 KW shall be provided with microprocessor-based MPR. Terminal blocks for power and control wiring. Anti-condensation heater for MCC and interlocks for the anti-condensation heaters of MCC and motors shall be provided. Heavy duty O/L relay shall be provided for motors with longer starting time.
- (iii) The short circuit interrupting capacity of ACB/MCCB's shall be 35 kA minimum.
- (iv) The MCCBs shall be suitably rated with due regard to the climatic conditions at site. The MCCBs provided in the motor feeders shall be suitable for the motor starting duty wherein the starting current asymmetry, peculiar to the motor, has been considered.
- (v) MCCB's with magnetic and thermal releases shall be provided for auxiliary (non-starter) feeders of the MCC.
- (vi) 20% of spare feeders of each rating subject to minimum of 1 shall be provided.
- (vii) Contractor shall furnish to the Employer, graph showing co-ordination of thermal overload relays and MCCB releases, co-ordinated with the motor thermal withstand abilities (for both cold and hot conditions) and get the same approved before incorporating them in the MCC. The effect of ambient temperature shall also be considered in the selection of MCCB's.

(e) **Wire ways**

- (i) A horizontal wire way, extending the entire length, shall be provided at the top for inter-panel wiring.

(ii) A full height vertical wire way with cable supports for mounting cable clamps shall be provided for each section to facilitate cabling. The wire way shall be liberally sized to accommodate all power and control cables and shall have a hinged and lift-off type cover at the front for access.

(f) **Panel Heater**

(i) Anti-condensation heater with thermostat control shall be provided in the MCC.

(g) **Earth Bus**

(i) An earth bus shall run along the entire length of the panel which shall be connected to the system earth.

C909.12 Installation

C909.12.1 Conductors between drives and motors shall not be combined in conduit. Each drive/motor combination shall be separately wired.

C909.12.2 Power Factor and % Harmonic Distortion

C909.12.3 It will be the responsibility of the Contractor to measure and prove that the Power Factor at the Main Incomer of the equipment is 0.95 and 3% Total Harmonics Distortion.

C910 CABLES

(i)

C910.1 LV Cables (System Particulars)

(a) **Power Cables**

- | | |
|-----------------------------|------------|
| (i) Voltage Grade: | 1100 V |
| (ii) Normal system voltage: | 415V + 10% |
| (iii) Frequency: | 50 Hz + 3% |

C910.2 Conductors

(a) **LT Cables**

The conductors shall be made from electrical purity copper and shall confirm to IS: 8130 conductors shall be stranded and circular in cross section up to the size of 25 sq.mm. and above shall stranded & shaped. Minimum cross of conductor's power shall be 6 sq.mm. and for lighting shall be 2.5 sq.mm.

C910.3 Insulation

(a) **XLPE Insulation (For LT Power Cables)**

The insulation shall be chemically cross linked polyethylene conforming to the physical, electrical and ageing properties as required by IS:7098 (Part I & II). Only natural unfilled compounds shall be used for insulation of cables. the insulation shall be free from micro voids and shall be heat resistant.

C910.4 Inner Sheath

C910.4.1 For all cables having two or more cores, the individual cores shall be laid up and then be surrounded by common covering applied either by extrusion or wrapping or filling material containing a thermoplastic material. A proofed or plastic tape may be applied over the common covering when a wrapped common covering is employed. It must be ensured that the circularity of the cable is maintained.

C910.5 Armouring

C910.5.1 Armouring shall be arranged over the inner sheath for the cable consisting of two or more cores. The armour of cables shall be either of galvanized steel wires or galvanized steel strips.

C910.6 Outer Sheath

C910.6.1 A tough outer sheathing of PVC insulating material in standard colours shall be provided over the armouring to offer a high degree of mechanical protection against abrasion.

C910.7 Colour Scheme for Identification of Cores

C910.7.1 Cores shall be identified by colour scheme of PVC XLPE insulation. The following colour scheme shall be adopted:

Phase A	Red
Phase B	Yellow
Phase C	Blue
Neutral	Black
Control	Red/Black
Earth	Green/Yellow

C910.7.2 For control cables having more than five (5) cores, two adjacent cores (counting and directional) in each layer may be coloured blue and yellow respectively and the remaining cores may be light grey.

C910.8 Earthing

C910.8.1 The rails will be connected to the earthing system of the overall facilities. However, each equipment shall be supplied with four spring-loaded soft iron-earthing shoes. Two numbers of these earthing shoes shall continuously press against each rail. All shoes shall be parallel connected to the earthing grid inside the equipment. Twelve numbers of spare shoes shall be supplied with each equipment.

C910.9 Approved Makes of Major Electrical Components (Equivalent Higher Standard Makes)

S. No.	Description	Approved Makes
1	LT Switchgear Panel	Siemens / L&T / ABB / Schneider
2	HT XLPE Cable	Universal / Nicco / Polycab/KEI/RPG
3	LT XLPE Cable & Control	Universal / Nicco / / Havells / CCI/Polycab
4	Trailing Cable	Jettyelli / Covotec
5	Power & Distribution Transformer	Areva / Emco / Crompton / BHEL / Voltamp
6	Capacitor Bank	L&T / Siemens / Epcos / Mehar
7	Battery	Exide, Amco, Amara Raja
8	Battery Charger with DCDB	Chhabi Electricals / Caldyne / DB Electronics
9	Cable Trays	Ercon / Indiana / Industrial Perforation
10	DG Set	Powerica / Jakson / GMMCO / Kohler / Greaves
11	Welding Socket	B&C / BCH
12	PLC	ABB / Rockwell Automation / Siemens / L & T
13	PA System	Philips / Bosch / Ahuja / Motwane
14	Telephone System	BPL / Siemens / Bharti / Tata Telecom
15	Pressurization &	Almonard / C Doctor / Thermax

S. No.	Description	Approved Makes
	Ventilation System	
16	Distribution Boards	L&T / Siemens / Schneider / ABB / Indo Asian / Milestones / Pyrotech / Technocommerce / Bengal Technocrats
17	Copper Wires PVC FRLSH	Skytone / Echo Cables / Batra Henlay /National / Finolex / Polycab
18	Bus Duct	Stardrive / B&C / United Electric / Godrej / Power Gear/ Control & Switchgear
19	Cable Glands/Lugs	Jainsons / Dowells / Gripwell
20	GI Conduit with accessories	BEC / AKG / SENCO / Jindal
21	LT Motors	Siemens / ABB/ Crompton / Alstom
22	VVFC	Rockwell Automation / ABB / Siemens / L & T
23	Air Conditioning Unit	Blue Star / Voltas / Carrier / Hitachi
24	UPS	Emerson / MG / Hi-Rel
25	Pull Chord/Belt Sway Switches Electronic Speed Switches	Jayshree / Bengal Technocrats / Kakku
26	Voltmeter / Ammeter / PF Meter / Frequency Meter/ KWH Meter	AEI / IMP / MECO / INDCOIL / Enercon / L&T
27	Local/Remote Control Switch	L&T / Kaycee / Siemens / Control & Switchgear
28	Overload Relay	L&T / Siemens / Telemehaniq / BCH

S. No.	Description	Approved Makes
29	Power Contactor with 2NO+2NC	L&T / Siemens / Telemecanique
30	Current / Potential Transformer	AE / Kappa / L&T / Siemens / Pragati / Control & Switchgear
31	Fuses	Siemens / L&T / Alstom / Schneider / Control & Switchgear
32	Push Button Stations	Control Group / Alstom / BCH / L&T / Siemens / Technic
33	LT Switches	Siemens / L&T / Havells / Control & Switchgear / Kaycee
34	Indicating Lamp / Push Buttons	Siemens / L&T / BCH / Vaishnav / Control & Switchgear
35	Protection Relay	Alstom / ABB / Siemens / Easun Reyroll
36	Auxiliary Relay	Siemens / Telemecanic / L&T
37	Timer	Siemens / BCH / L&T /
38	MCB	Siemens / L & T / Schneider / GE Power Control /MDS/Havells
39	MCCB	Siemens / L&T / Schneider / ABB / GE Power Control / Control Group
40	ELCB	Siemens / L & T / MDS / Schneider
41	Switch Fuse Unit	Siemens / L&T / Havells
42	Lighting Panels	Siemens / L& T / Schneider Electric / GE Power Controls / Havells / Indo Asian / MDS
43	Plate-Switches & Sockets, Boxes	M.K. / Crabtree (Havell) / Anchor
44	Lighting Fixtures	Philips / Bajaj / Crompton / GE Lighting / Wipro
45	PVC Conduit and accessories	BEC / Polypack / Precision /AKG
46	Voltmeter/Ammet	L&T / Kaycee / Siemens / Vaishnav

S. No.	Description	Approved Makes
	er Selector Switch.	

C910.10 All makes other than as mentioned above shall be furnished to Employer for approval.

C911 FIELD TESTS

C911.1 Tests

C911.1.1 The tests shall comprise the following:

- (a) Equipment/unit assembly test.
- (b) Contractor(s)' adjustments and settings.
- (c) Satisfactory completion of no load tests for each equipment.
- (d) Final Operational Tests such as Commissioning and Performance Guarantee Test of each equipment.

C911.1.2 Before any electrical system is put to use, the Contractor(s) shall carry out the following tests at site in the presence of and to the satisfaction of the Employer.

- (a) Insulation resistance tests on cables, motors and switchgear.
- (b) Polarity tests wherever applicable.

C911.2 General

C911.2.1 Contractor(s) shall be responsible for testing the individual components of the equipment according to Contractor's standard testing procedures. Checklists for the equipment tests shall be submitted to the Employer for approval.

C911.2.2 For the period of adjustments and setting, the Contractor(s) shall provide services of adequate number of teams of personnel which shall include, but not be limited to, Employers, foremen, fitters, welders, electricians, etc., who apart from their technical experience are well acquainted with all the machinery and equipment.

C911.2.3 All tests shall be carried out in the presence of the Employer and any corrections found necessary shall be approved by the Employer and the Contractor(s) shall be responsible for producing all necessary work sketches and drawings for the approval of the Employer. The Contractor(s) shall be responsible for obtaining the services of sub-contractors (as and when necessary).

- C911.2.4 Final operational tests by the Contractor(s) with load will depend on the availability of material, ship and interfacing equipment / system falling under the scope of other contractors. The Employer will set the date for operational tests after receipt of the notice(s) from the Contractor(s) and the Contractor(s) will be informed of this date in advance. The Contractor(s) shall be responsible for any adjustments or corrections found necessary during these tests.
- C911.2.5 Employer will ensure that interfacing equipment / system (by others), such as truck, tractor-trailer, etc., are ready to work in conjunction with the equipment falling under the scope of the Contractor.
- C911.2.6 The Contractor shall be responsible to coordinate/exchange of technical inputs, as may be found necessary during load trials with the other contractors.
- C911.2.7 Interruption / delay due to malfunctioning / adjustments in the equipment / system by other Contractor(s) during commissioning may occur. The Contractor(s) shall account for such interruptions / delay during the tests (except the Performance Tests).
- C911.2.8 The Contractor(s) shall during the period of Field Tests instruct the Employer's staff in the operation of the equipment and acquaint them with the adjustments that are made. The Employer's staff shall be given reasonable opportunity to become conversant with the operating features of the equipment.
- C911.3 Adjustments
- C911.3.1 Contractor(s) shall be responsible for all necessary alignment and adjustment of machinery and equipment to obtain the agreed specification.
- C911.3.2 All critical and specialized adjustments shall be carried out in the presence of Employer. Procedures and necessary precautions in regard to such adjustments shall be conveyed to the Employer in writing.
- C911.4 No Load Tests
- C911.4.1 After completion of the erection the equipment and machinery shall be tested. The equipment shall be run without load and all necessary adjustments shall then be completed. The no load tests are intended to demonstrate that all components will function successfully, separately and as components of an integrated machine in accordance with the requirements of the contract documents.
- C911.4.2 After completion of erection, all machinery and equipment shall be tested individually and with related equipment by the respective Contractor. Equipment shall be operated through the entire range of travel and speeds as far as it is practical under the circumstances. All necessary adjustments shall by then have been carried out. The tests shall demonstrate that the equipment, as applicable, can raise, lower, hold the load in any position and travel without excessive deflections to the frame. Additionally, all the prime motions shall be demonstrated at no load in all directions. During the tests, the various speeds of different motions shall be achieved.
- C911.5 Load Tests
- C911.5.1 Load Tests shall be undertaken in two phases:
- C911.5.2 Phase A

- C911.5.2.1 Testing of all components shall be made as a dry run. Each system or component shall first be run individually under manual control, then in automatic mode to check interlocks and the associated schematics. At this stage the equipment shall be completed in all respects excluding minor items like painting, etc.
- C911.5.3 Phase B
- C911.5.3.1 When Phase 'A' is completed to the satisfaction of the Employer, the Employer on being intimated by the Contractor and subject to all statutory clearances obtained by the Contractor, shall arrange for requisite loads for carrying out the following tests:
- C911.6 Performance/Commissioning
- C911.6.1 Employer shall supply the cargo for loading and the number of personnel trained by the Contractor(s), within 3 days of the above notice provided the Time for Completion has been adhered to. In case of delay in completion by the Contractor test dates will be fixed subject to clause entitled 'General' above.
- C911.6.2 If the Employer's obligations under the above sub-clause are fulfilled, Contractor(s) shall commence commissioning under the supervision of the Employer. The Employer will be responsible for co-ordination with all Contractors concerned.
- C911.6.3 Commissioning tests by the Contractor(s) shall include but not necessarily be limited to the following:
- (i) Check that all systems are complete, clean and clear of obstructions and ready to test.
 - (ii) Contractor shall check, test and calibrate the weigh scales for required accuracy in the presence of officers of the Inspectorate of Weight and Measures and other statutory bodies and shall produce a certificate to the effect. Calibration of other instruments shall be checked and instruments shall be re-calibrated if necessary.
 - (iii) Limit switches checked for location and that they operate satisfactorily adjust as necessary.
 - (iv) All equipment to be tested. Each motion to be operated over full range.
 - (v) All centralized controls, monitoring devices, safety devices, visual and audible indications, etc., to be tested.
- C911.6.4 Records shall be kept of the tests carried out, faults/defects noticed and corrections made, and four copies of such records shall be submitted to the Employer by the Contractor.

Notes:-

- (a) The Contractor shall put his best effort to ensure least stoppage of loading / unloading operation during carrying out all the tests when ship is waiting. More than ten hours breakdown time per ship is not anticipated.
- (b) Generally minor shortcomings shall be those which, according to the Employer, shall not affect safe operation. Items which could be considered 'minor' would depend on the nature of malfunctioning and such decisions shall be taken solely by the Employer after completion of the Performance Tests.
- (c) The Contractor shall arrange for responsible representatives and competent Employers to be present throughout the tests.
- (d) The Contractor shall have the option to carry out the tests/trials/handling of cargo during non-tests/trial period up to taking-over mentioned herein either entirely with his own personnel or assisted by the Employer's personnel. In either case Employer shall be informed in advance.
- (e) All materials and equipment which fail the tests during various tests shall be replaced by the Contractor without any extra cost to the Employer and the tests shall be repeated on the new equipment/item unless it is agreed otherwise by the Employer. All instruments and tools required for tests shall be supplied by the Contractor at no extra cost to the Employer.
- (f) In case, in the assessment of the Employer, the tests are unreasonably delayed or prolonged once a ship has been provided for testing, the Employer may discontinue the tests to release the ship and instruct the Contractor to reschedule fresh tests.

C911.7 Guarantee and Satisfactory Operation

- (a) The contractor shall give guarantee of satisfactory operation of the cranes for a period of 24 months from the date of taking over the cranes in satisfactory working condition by Employer. However, if during guarantee period any rewinding work or repair works to the electric motors, thrusters etc., is required to be carried out, the same shall be attended and shall be under the supervision by the contractor. The contractor shall arrange all tools, tackles and precision instruments for carrying out the work.
- (b) The following minimum skilled and supervisory staff will be posted for the above purpose.

1	Electrical & Electronic Engineer	:	01 in day shift only
2	Skilled Staff	:	02 in each shift

- (c) During the guarantee period if any of the spare from insurance spares provided with the cranes is used by the contractor, the same shall be replenished within reasonable period. On completion of guarantee period complete inventory of insurance spares supplied with the crane should be available for AMC.
- (d) Procurement, stocking and use of maintenance spares as well as consumable wire ropes, lubricants, electrical lamps & switch gears, seals, brake liners, etc. required for satisfactory performance during guarantee period is the responsibility of the contractor.

C912 SPARES:

C912.1.1 Following spares shall be supplied along with the crane.

(i) Travelling Machinery:

Brake lining – 4nos

Driving wheel assembly including wheels and bearing- 1 set

(ii) Hoist Machinery:

Brake lining – 1 set.

Rope pulley with bearing-2nos

Full Brake set – 1No

(iii) Slewing Machinery:

Brake lining – 1 set.

Full Brake set – 1No

(iv) Luffing Machinery:

Brake lining – 1 set.

Full Brake set – 1No

(v) LT motor with brake unit-1 no.

Full Brake set – 1No

(vi) Rectifier for magnet disc brake – 2nos

(vii) Solenoid valve for rail clamp-2 nos

(viii) Encoder -1no for each motion

(ix) Control contactors of each motion- 2 nos each for each motion

(x) Emergency stop-2nos

(xi) Long travel, luff, hoist limit switch-2nos each for Luff & hoist and 2nos for long travel

- (xii) Aviation light- 1nos.
- (xiii) Jib light fitting-3nos
- (xiv) Slew frame light fitting-1nos
- (xv) Long travel warning horn-1no
- (xvi) Long travel warning light-1 no
- (xvii) Cable reel motor – 1 no.
- (xviii) Control system:
 - Programmed PLC-1 no.
 - Power supply module-2 nos
 - PLC D/I module-2 nos
 - PLC D/O module-2 nos
 - PLC analog input module -1 no.
 - PLC Analog output module -1 no.
 - PLC communication module-1no
 - Fibre optic converter-1no as applicable
- (xix) VVVF drive
 - Common power module – 1 set (for same chassis)
 - Common Control module – 1 set (for same chassis)
- (xx) Sensors Optical or Proximity: 2 each.
- (xxi) Operators cabin console items – 1 set (each unit 1 no.)

C913 LIST OF APPROVED MAKES OF TOWER CRANES

- Liebherr
- Terex
- Sennebogen
- Escorts
- COMANSA

C1000 EOT CRANE

C1001 GENERAL

C1001.1 Scope of Supply

C1001.1.1 Scope of supply covers the design, manufacture, supply, erection and commissioning of EOT Cranes as detailed below. However, this specification is for reference and the Contractor has to check and assess exact design requirement for the EOT crane. This specification does not in any way absolve the Contractor's responsibility for exact supply erection and commissioning and maintenance for its intended use.

C1001.1.2 All the above cranes will be as per IS: 3177 Class M5 (II), IS: 807 and other relevant standards and this Specification and complete with all Electricals, Radio Remote Control, Crane weighing system and standard accessories as per requirement of each crane. Cranes must be rugged and robust in operation as per their nature of work.

C1001.1.3 The following should accompany at the time of approval from Employer:

- (a) General Arrangement (GA) drawing to scale (showing elevation, cross section and plan of the crane) indicating clearances, hook approaches, hook height, details of pendant push button operation and Radio Remote Control (RRC), wheelbase, wheel loads with spacing etc.
- (b) Information as required in these specifications.
- (c) Design calculations for all motions, structure etc., and selection of bought out items for deciding the suitability of offer. In absence of this information, the offer may be ignored.
- (d) Deviations from this specification, if any.
- (e) The GA drawings containing all information as described in Clause 2.0 (a).
- (f) General layout drawing of the trolley.
- (g) Assembly drawing of hoist, long travel and cross travel.
- (h) Circuit diagrams showing the wiring for the complete crane.
- (i) Final Design calculations for all motions, structure etc., should be submitted at the time of approval of GA drawings.
- (j) Quality Plan

Note:

The Contractor is required to measure all necessary dimensions i.e. Span, Head Room, Power supply system (DSL) and rail size etc., at site before starting of the crane design / manufacturing.

- C1001.1.4 The following documents/ information are to be supplied prior to commissioning of the crane.
- (a) All the drawings approved by the employer along with all workshop drawings for structural and mechanical items containing full information such as tolerance, heat treatment etc.
 - (b) Operation & Maintenance manuals- 5 Sets, Maintenance Schedule, Lubricating Charts, Electrical circuit diagrams, catalogues of all electrical equipment and drawings mechanical spare part (i.e. Gears, Wheels, drum, drive shafts) etc. along with information on any other specific feature/s. Two sets of CD's containing the documents / information recorded on it should also be supplied.
- C1001.1.5 A toolbox containing all necessary tools (e.g., torque wrench, hand grease gun, set of spanners, screwdrivers etc.) required for the maintenance of the crane should be furnished along with the Crane.
- C1001.1.6 The Contractor should furnish material test certificates for all electrical equipment, cables, and parts used in handling loads (e.g. wire ropes, chains, hooks etc.), structural steel, mechanical components such as couplings, gears boxes, rope drums, pulleys, shafts, wheels etc.
- C1001.1.7 The Contractor should ensure that the crane is manufactured as per tolerances specified below.
- (a) Span over L.T. Wheels 65 mm
 - (b) Diagonal on Wheels 63 mm
 - (c) Long travel wheel 61 mm
 - (d) Tilt of wheels or balance axle 62mm/1000mm (Horizontal and vertical)
 - (e) Trolley wheel gauge 63mm
 - (f) Trolley track gauge 63mm
 - (g) Difference in height between trolley rails 6H depending upon trolley track gauge.

Trolley track Gauge S (mm)	Difference in height between trolley rails 6H
Up to 2500	4
2500 to 4500	6
Above 4500	8

- C1001.1.8 Speeds at full notch with rated load, Voltage and frequency should be as follows.

Traveling and Traversing = +10% /-5%

Hoisting = +10% /-5%} of specified speed
Lowering = +25% /-5%}

- C1001.1.9 Assembly at site is to be kept as minimum as possible to enable early commissioning of the crane. Welding at site is to be avoided as far as possible. The Contractor should satisfy himself about the site condition beforehand to avoid any difficulty during erection and commissioning of the crane.
- C1001.1.10 In addition to the tests specified in the IS tests as under should also be done after erection.
- C1001.2 Speed Test
- C1001.2.1 Rated load Test: All the motions should be tested with rated load and the rated speeds should be attained within the tolerance limits indicated under clause 7 (h).
- C1001.3 Overload Test
- C1001.3.1 All motions of the crane should be tested with 25% overload in which case the geared speeds need not be attained but the crane should show itself capable of dealing with the overload without any difficulty.
- C1001.4 Brake Test
- C1001.4.1 The hoist brakes should be capable of braking the movement under conditions a (I) and a (II) of speed tests.
- C1001.4.2 The long travel and cross travel brakes should be capable of arresting the motion within a distance in Meters equal to 10% of the speed in M/Min.
- C1001.4.3 After the load test has been performed, the wheel loads should be checked. The wheel load measurement should not deviate from the values mentioned in the static calculations by more than +3% for maximum and -3% for minimum wheel loads. Load for job proving shall have to be arranged by the Contractor.
- C1001.4.4 Guarantee shall be provided for 24 months after the date of commissioning of cranes.

C1002 REQUIREMENTS

- C1002.1 Technical
- C1002.1.1 The crane should be designed in accordance with the latest editions of IS: 807, IS: 3177, other relevant standards referred to therein and also in accordance with the requirements specified herein after.
- C1002.1.2 Safe access for maintenance and removal of all mechanical and electrical parts must be ensured without any additional scaffolding. All parts requiring periodic inspection/ lubrication/ replacement should be easily accessible without the need for dismantling other equipment or structures. All electrical cables should be so laid that they are not liable to be damaged and can be easily inspected and maintained.
- C1002.1.3 All machinery or equipment included in this specification must be provided with safety devices and clearances as per standards and employer's requirements.

- C1002.1.4 No cast iron part should be used on the crane except for electrical equipment. Similarly wood or combustible material and Bush bearing should not be used in any part of the crane. Open gears should not be used in any drive/motion.
- C1002.1.5 Full length and full width chequered plate platforms should be provided on the top for the bridge girders in order to have access to operator's cabin, long travel drive, current collectors, trolley etc. Access to the cabin from the bridge girder platform should be via a staircase unless specified otherwise. Minimum width of the staircase should be 600 mm and inclined to the horizontal at an angle not more than 45°. Passage through staircase should be fully protected to prevent any accident/ fear of accident.
- C1002.1.6 Foot-walk should be of sufficient width to give at least 500 mm clear passage at all points, except between railings and bridge drive where this clearance may be reduced to not less than 400 mm.
- C1002.1.7 All openings in foot walk flooring for access to bottom chord platforms and inspection platform should be provided with strong hinged covers. These covers in the maximum open position should be inclined at an angle slightly more than 90° to the horizontal and should be provided with a locking device both for the closed and fully opened position. They should be so located that in their open position, they should not foul with any moving part of the crane. Minimum size of hatch opening should be 600 X 600 mm. Any other opening in foot-walk or end carriage should be provided with bolted removable plate covers.
- C1002.1.8 Suitable Guards to push away any object lying on the rails should be provided at the ends of the end carriages.
- C1002.1.9 All wheels, couplings etc. should be provided with covers opening on strong hinges. These covers should be preferably be made of minimum 5 thick plates. All heavy covers should be provided with inspection windows.
- C1002.1.10 Guards should be provided on the crane to prevent the hoist ropes from coming into contact with the down-shop leads.
- C1002.1.11 All bolts except those with Nyloc nuts should be provided with grip lock nuts or spring washers.
- (a) For side alignment of motors, strong adjustable screws with lock nuts should be provided. However, for IEC frame size motors this is not considered necessary.
 - (b) Welded lugs should be fitted against the feet of all pedestals, gearboxes etc. except motors. Motors should be provided with alignment screws for side alignment.
 - (c) Fasteners for pedestal blocks, motors, gear boxes etc. should be easily removable from the top of platform. Studs or body bound bolts should not be used as fasteners for mechanical items except for fixing covers.
- C1002.1.12 All cables should be clamped individually. All trailing cables should be clamped with PVC or non-metallic clamps. Deviations are permissible only with Employer's specific approval.

- C1002.1.13 Safety hand railings preferably of tubular construction should be provided on bridge foot-walks, end carriages, stair cases, landing in cabin, trolley and in any other place where access has been provided. Railings should not be less than 1000 mm high with an intermediate member at a height of 500 mm. All edges or openings should be provided with toe guards, toe angles or bent plates wherever required and should be of height 100 mm (minimum).
- C1002.1.14 Parts of steel frames carrying machinery should be provided with doubling plates of adequate thickness riveted or welded and machined to true surface.
- C1002.1.15 Defects in materials like fractures, cracks, blowholes, laminations, pitting etc. are not allowed. Rectification of any such flaw is permissible only with the approval of the Employer.
- C1002.1.16 Spring buffers for both LT & CT, Anti-Collision system to be provided.
- C1002.1.17 All the components should be in metric sizes only.
- C1002.1.18 Wheels should be made of C55 Mn75 Carbon steel, Hardened to BHN 280-320.
- C1002.2 Structural
- C1002.2.1 In addition to the latest edition of IS-807, following additions/deviations are applicable.
- (a) Welded joints should be used unless otherwise specified.
 - (b) Not less than four turned, fitted bolts or equivalent length of welding at each joint should be used for connections.
 - (c) Black bolts should not be used in the main structures of the crane and high tensile steel bolts should not be used unless approved by the Employer.
 - (d) Bolts used in shear should be fitted into reamed holes.
 - (e) Transverse fillet welding on load carrying members should be avoided.
 - (f) 100% of top & bottom flange, 40% of web plate of box girder and 25% of circular joints should be radio-graphed to ensure freedom from defects. Rest of the weld joints of Girder and Hoist Drum should be tested ultrasonically. All reports are to be submitted to the Employer for approval.
 - (g) Plates, bars, angles and where practicable other rolled sections used in the load bearing members of the structure should be not less than 8 mm thick. Minimum thickness of chequered plates for platforms should be 6 mm over plain. Chequered plates should not be considered in computing strength of load carrying members.
- C1002.3 Bridge Girders
- C1002.3.1 The crane should be single-box girder. The bridge girder should be of box construction and in one piece. The girder should have double web plate. Girder should be sufficiently strong and rigid to withstand the most severe combination of loads that may develop under different working conditions.
- C1002.3.2 Top flange of the girder should not be considered as giving support to the rail, in computing the rail size.

- C1002.3.3 Trolley rail section should not be considered in the design of the bridge girders.
- C1002.3.4 Full length wearing plate should be provided under the trolley rails. The wearing plates should be 10mm thick and welded in place to the flange with minimum 5mm continuous welds. The wear plates should be 10 to 12mm lesser in width than the rail base such that the welds of the wear plates do not project beyond the rail base. Wearing plate should not be considered in the strength calculations of the bridge girders.
- C1002.3.5 Box girders should be so constructed as to eliminate accumulation of water or oil inside them. Squaring marks should be provided on each girder to facilitate erection and squaring of the bridge.
- C1002.4 End Carriages
- C1002.4.1 End carriages should be fabricated from plates welded together to form a box except for essential openings, which should be reinforced. If more than two wheels are required, bogies should be provided or articulated end carriages should be used. Wherever possible, the end carriages should be in two halves. Each half should be fitted to the respective bridge girder in the fabrication shop.
- C1002.4.2 End carriages should be of ample strength to resist all stresses likely to be imposed on them under service conditions including collision with the cranes or stops. The length of end carriages should be such that no other part of the crane is damaged in collision.
- C1002.4.3 On the end carriages with more than two wheels, the wheelbase should be taken as the distance between the centres of the outside wheels.
- C1002.4.4 The end carriages should be fitted with substantial safety stops to prevent the crane from falling more than 25mm in event of breakage of a track wheel, bogies or axle. These safety stops should not interfere with the removal of wheels.
- C1002.4.5 Suitable jacking pads at a height of 300mm from rail level should be provided on each end carriage for jacking up the crane when changing track wheels. Jacking pads should not interfere with the replacement of wheels.
- C1002.5 Trolley Frame
- C1002.5.1 Trolley frame should be produced in one piece. Drum bearings and supports for upper sheaves should be located so as to equalize the load on the trolley wheels as nearly as possible.
- C1002.5.2 The trolley frame should be built up of rolled sections and plates to form a rigid structure capable of withstanding all stresses that will develop during the working of the crane and should be arranged to afford maximum accessibility to mechanical and electrical parts placed on it. It should be designed such that at the highest position of hook there should be clear distance of 700mm between the lowest point of bottom block. Deviation should be made only with specific approval of employer.

- C1002.5.3 The top of trolley frame should be covered with plates all over except for openings required for the ropes and flexible cable for bottom block etc, to pass. The openings in the trolley frame should be such as to keep the ropes or cables at least 125mm away from any part of the trolley frame. The equipment should be placed above the trolley top plates as for as practicable.
- C1002.5.4 For any parts placed below the trolley top plate, access for maintenance, repair and replacement should be provided. Hand rails should be provided on all the four sides of the trolley (except in case where protective guard is fitted on the trolley conductor side, hand rails on the three sides only should be provided) with openings on the platform side opposite to the trolley conductor side.
- C1002.5.5 The trolley should be fitted with substantial safety stops to prevent the trolley from falling more than 25mm in the event of breakage of a tack wheel, bogies or an axle. This safety stops should not interfere with removal of wheels.
- C1002.5.6 The trolley should be provided with lifting pads for jacking up the trolley on all Four Corners for wheel removal. The jacking pads should be at a height of about 300mm from the rail level and should not interfere with the removal of wheels.
- C1002.6 Trolley Rail
- C1002.6.1 Trolley track rails made of MS Bright Bars Rails should be made continuous by welding standard lengths. At splice joints, rails may be welded at site and as such, edge preparation of the rails should be done in the supplier's work.
- C1002.7 Repair Cages
- C1002.7.1 Repair cage should be provided on the inside of the end carriage for attending to the current collectors. Repair cage should also be provided at the corners of the crane to facilitate removal of Long Travel wheels. The repair cages should be minimum 1000 mm wide and should be such that two persons can work comfortably in the space provided. The floor of Repair cage should be about 1500mm below the LT wheel centres.
- C1002.7.2 The cages should be of structural steel and should be made substantially rigid by gusset plates and brace welded or riveted. Repair cages should be provided with railings on all sides except for the repair cages on the down shop lead, which should be provided with easily removable type protection guards on three sides for safety reasons.
- C1002.8 Mechanical
- C1002.8.1 The following features are required in addition to those specified in relevant standards.
- C1002.9 Drive Mechanism
- (a) Long Travel
 - (i) One brake for each drive.
 - (ii) Total no. of wheels should not be more than 4 – (two on each side)

(iii) LT Drive should be 2 motor drive, driving not less than 50% of wheels provided. If any motor fails, the other motor should be able to operate the crane.

(iv) One brake for each drive.

(b) LT Drive should be single motor drive per two wheels, (driving two wheels on same axis) is acceptable.

(c) Main Hoist -

(i) Total no. of falls should not be more than 4 for 5T hoist and should not be more than 4 for other main hoists.

C1002.10 Gearing

C1002.10.1 Straight and helical spur gearing should normally be used for all motions. Worm, reducer and bevel gears should not be used. First and high speed reductions should be through helical gears. All first reduction pinions and also the other pinions if feasible should be integral with the shafts. All gears should be of hardened and tempered alloy or carbon steel with machine cut teeth. Gear tooth should be cut in metric module system. Surface hardening of teeth is not allowed. Material of gears should be EN8 or equivalent.

C1002.11 Gearbox

C1002.11.1 Totally enclosed gear boxes with splash or automatic lubrication system should be used. The gearboxes should be fabricated using steel plate of thickness 8 mm (min). Covers should be split horizontally at each shaft centre line and fastened so that the top half can be removed for inspection and repair without disturbing the bottom half. Open type gearing is not acceptable.

C1002.12 Bearings

C1002.12.1 Ball and roller anti-friction bearings of FAG, SKF make should only be used throughout except where specified otherwise. Grouped grease lubrication system for bearings may be provided wherever possible. Automatic centralised lubrication is preferred.

C1002.13 Couplings

C1002.13.1 Motor shafts should be connected to gear extension shafts through flexible shock absorbing couplings. Geared or universal couplings should be used between gear box output shaft and intermediate shaft and wheel axle. Any other special coupling which can give better and more reliable service may be used after obtaining specific approval of the Employer. Pin Bush coupling should not be used.

C1002.14 Lifting Hooks

C1002.14.1 Standard shank type plain hook for the Main Hoist and for Auxiliary Hoist should be used. These hooks should conform to the latest edition of IS: 5749 and IS: 15560 or or IS 3815 any other relevant Indian / International.

C1002.15 Brakes

C1002.15.1 DC Disc brakes should be provided for each drive. Brakes should be mounted on the input pinion shaft of the gear train.

C1003 ELECTRICAL

C1003.1 Scope of Supply

C1003.1.1 The crane electrics include, power disconnecting switch on the crane bridge walkway immediately after the main current collector gear, protective switch gear, motor control panels, resistors, Electro Hydraulic thruster operated brakes (alternatively disc brakes), limit switches, power and control cables, socket outlets, lighting distribution panel and lighting fixture with lamps, Bridge current collector system, indication lamps, push buttons and equipment earthing material. All sundry erection materials required for installation and connection of electrical equipment with cable laying and fixing accessories should be in the scope of supply. Preferred make for basic electricals like contactors, MPCBs, ACBs, MCCBs, etc. is to be Siemens/ABB. All timers are to be pneumatic type and BCH make. The protective and power panels are to be fuseless. ACBs are to be used at incomer, everywhere else; MPCBs must be used for protection of motors / thrusters / circuits, etc. All indicators to be LED type. All equipment should be of robust construction. All cables to have bottom entry into panels. Power and control terminals to be grouped separately with 10% extra terminals in each group. In general, the control voltage to be 220V AC, single phase, 50Hz. All trailing cables to be of reputed make EPR cables. Good quality junction box to be used for connecting EPR and PVC cables.

C1003.2 Climatic Conditions

C1003.2.1 The equipment offered should be suitable for tropical and humid climate. For the purpose of equipment selection and specially for de-rating the capacities of drive motors and power cables, the ambient temperature 45°C should be taken as the basis. The equipment on the crane should be suitably protected against damage from radiant heat and should be rendered proof against ingress of dust and vermin.

C1003.2.2 The equipment should be selected, assembled and tested as per guide lines provided in the latest edition of Indian Standard Specification Nos. IS: 3177 for Class-II (M5) duty. The equipment should also conform to the latest Indian Electricity Rules and regulations as regards Safety requirements, earthing and other essential provisions specified therein. The equipment should be designed and selected to facilitate inspection, cleaning, replacement and repair and for use where continuity of operation and safety are first considerations. Wherever power cables having aluminum conductors are used for connecting up the electrical equipment on cranes, ample internal space for easy termination of these cables in the terminal boxes of the machines should be ensured.

C1003.3 Power Supply Conditions

C1003.3.1 The power available at existing down shop leads is 415V, 3 phase, 3 wire, 50 Hz. The equipment selected should be suitable for operation on 415V± 10%V.

C1003.3.2 The following voltages should be used in the cranes.

400/415 + 10% V, 3 ph,50hz, AC	For motors and electro-hydraulic thrusters
415/220V, single phase Isolating Transformer	For control circuit, lighting and fan
24V, single phase, 50hz, AC	For hand lamp socket outlets
110 V, AC, 1- ph, 50 Hz.	For control circuits as applicable
24V, DC	For disc brakes as applicable

C1003.3.3 The different voltages mentioned above other than 415V, 3 ph, 50Hz, AC should be obtained through individual separate transformers and transformer rectifier units connected to 415 V, AC. Each transformer should be provided with tapping at $\pm 2 \frac{1}{2}$ and $\pm 5\%$ of secondary voltage.

C1003.4 Current Collection

C1003.4.1 The supplier should arrange for main current collector system as per existing system.

C1003.5 Bridge Conductors

C1003.5.1 The bridge conductors should be accessible for service. Bare copper wires should not be used as bridge conductors. Flexible trailing cable system mounted on retracting supporting system should be used. The conductors should consist of insulated multi conductor (or several single conductors) cables with permanent termination on the bridge and on the trolley. The flexible trailing cables should have ample length and should be supported by means of properly designed movable clamps. These clamps should be fitted with rollers and should run freely on guide rails allowing relative movement of bridge and trolley without undue stress or on the wear on the suspended cables. Consideration should be given to the inclusion of spare conductors to make provision for the later addition of additional conductors. The crane handles liquid steel for which the festoon cables should be selected accordingly and should be of reputed manufacturer.

C1003.6 Collector Shoes

C1003.6.1 The main current collectors should be of cast iron gravity type and Double collectors should be provided for all the three phases. The collectors should have adequate current carrying capacity. The design of collector should be such as to minimize the chance of binding at the hinge points due to dust or corrosion.

C1003.7 Collector Shunts

C1003.7.1 Current carrying shunts on all the collectors should be designed so that there is no danger of contact with adjacent collectors. The shunts should be easily replaceable.

C1003.8 Mounting

- C1003.8.1 All the collectors should be mounted on rigid steel shafts and suitably insulated there from. Electrical clearance between live parts of adjacent shoes should be at least 25mm. Flexible shunts in their least favorable position should not reduce this clearance. Collectors should be designed for ease of maintenance and so mounted that they are readily accessible for this purpose.
- C1003.9 Motors and Drive Control through VVVF System
- C1003.9.1 The crane should be provided with crane duty Squirrel Cage induction motors. Zero interlock of joysticks and gravity limit switches to be incorporated with line contactors. The supplier should furnish test certificates at the specified duty cycle for the individual motor. All the motors offered should be suitable for heavy-duty reversible crane service. The supplier should be responsible for selecting ratings that will meet the specified duty with the type of control specified. Ambient correction factors depending upon ambient temperature should be applied to de-rate the motor.
- Note:** - Copy of catalogue referred in selection of motors detailing against each, the rated capacity and frame sizes should be attached with the offer.
- C1003.9.2 All electrical equipment associated with the crane including motors push buttons, switches, control panels, starters, control transformers, relays, shall be in accordance with relevant Indian and International standards. A 3-phase, 3 wire power supply at 415 V, 50 Hz shall be provided by the Employer for the runway conductors through suitable L.T. Panel arranged at suitable location in the power house. All equipment and devices required thereafter shall be supplied by the vendor. Allowable temperature rise of the equipment shall be as prescribed in the relevant Indian Standards or the corresponding International Standards and shall be based on maximum ambient temperature.
- C1003.9.3 The motor shall be capable of delivering rated output under following variation in voltage and frequency.
- (a) Voltage variation +/- 10%
 - (b) Frequency variation +/- 5%
 - (c) Any combination of (i) & (ii)
- C1003.9.4 All motors shall be suitable for reversing frequent acceleration and mechanical braking. Motor shall be so located that brush gear and terminals are accessible for inspection and maintenance and normal ventilation is not restricted.
- C1003.9.5 All motors shall be 60 minutes (40% CDF) rating
- C1003.9.6 Electrical equipment mounted on bridge platform shall be enclosed type in sheet metal enclosure, with a provision for easy access to parts inside.
- C1003.9.7 The control panel shall be so spaced that efficient maintenance is possible and shall withstand the mechanical forces imposed by the crane under service condition.

- C1003.9.8 The type of equipment shall be a multi drive system, with inverters in one cabinet, one common rectifier with a common DC – bus, with inverters connected. This system will in case braking energy is being supplied from one motor, supply the energy to the next motor connected to the DC- bus. If the braking energy exceeds the energy used by the other inverters, a braking chopper will open, and supply the energy to a braking resistor.
- C1003.9.9 It is a vector controlled frequency converter. To achieve this, a pulse encoder shall be used at the motor to control the flux and phase shift, in order to obtain exact position of the rotor.
- C1003.9.10 All frequency converters are connected to control unit, called APC. APC is an “Application Process Controller”, where control of all the frequency converters is done.
- C1003.9.11 The control shall be closed loop vector control system.
- C1003.10 Detailed Specifications of Individual Equipment Motors for Various Motions:

(a)	Motor standards	As per IS: 325 and IS: 3177
(b)	Capacity	Of adequate capacity to suit respective duties. Full load torque of motors to be higher than the Maximum load torque.
(c)	Type and enclosures	All motors will be of squirrel cage type to suit 415 V AC, 3 phase, 50Hz, four wire power supply, totally enclosed. The motors shall be suitable for direct on line starting any hoisting/lowering rated load even in event of frequency control system being out of order , protection IP 54, with fan cooling arrangement.
(d)	Voltage & frequency variation	Voltage: $\pm 10\%$, Frequency: $\pm 5\%$, any combination values of Voltage & frequency variations within the above limits.
(e)	Pull out torque	Not less than 2.25 (Two point two five) times the full load torque of motors at rated voltage and frequency.
(f)	Insulation	class -F
(g)	Time rating	one hour for all motors

(h)	Temperature rating	Temperature rating - Max. Temp. rise at full load measured by resistance method shall not exceed 50 deg C. over the average ambient temp. of 45 deg C.
(i)	Rated syn. Speed	To suit duty for various motions.
(j)	Over speed with stand capacity	2.5 (two and half times rated speed or 2000 rpm whichever is less.
(k)	Motor bearings	Roller type, sealed to prevent grease leakage & entry to of dust of ample strength to with stand heavy shocks and vibration to which subjected under all conditions of operation.
(l)	Tests	Type and routine tests as per IS: 325. copies of test reports to be furnished by the Contractor.
(m)	Temp. rise measurement	By resistance method.
(n)	Climate	To be located indoor in tropical climate, to be provided with protection against fungus, vermin, and corrosion.
(o)	Terminal	To be arranged such that terminals are easily accessible for inspection and maintenance and natural ventilation is not restricted.
(p)	General	Sturdy and strong to withstand shocks and vibrations to which they get subjected.

C1003.11 Electrical controls & protection for operation of cranes

C1003.11.1 Each crane shall be provided with control panel located in the operator's cabin from where it shall be normally operated by the operator. The controls shall be provided for:

C1003.11.2 Individual independent control of the crane for all motions and various speeds up to normal speeds.

C1003.12 Speed Regulation

- C1003.12.1 Speed regulation shall be accomplished utilizing a static step-less control system for all crane motions. The hoist and travel motions shall be provided with step-less speed-regulation from 10 to 100% of rated speed. Speed control shall be achieved by adjusting the frequency of the motor electrical supply. (Combination of power Rectifier Bridge and inverter).
- C1003.12.2 The maximum acceleration produced by the control system shall be independent of the rate of change of the control lever position. The speed in the first lowering position shall not exceed 10% of the synchronous hoist speed when lowering any load up to rated load. The speed in the first hoisting position when lifting any load up to 125% of rated hoist capacity shall not exceed 10% of the synchronous hoist speed.
- C1003.12.3 The Vendor shall offer step-less frequency converter and digital control system for various crane drives. Full details of the system along with specification of components such as drive motors, brakes, limit switches, electrical control and protection of the cranes shall be furnished.
- C1003.12.4 The trolley travel controllers shall be provided with drift points in both directions of travel.
- C1003.13 Torque
- C1003.13.1 The pull out torque of the motors at rated voltage and frequency should be not less than 2.75 times of the nominal torque.
- C1003.14 Class of Insulation
- C1003.14.1 All motors should be class 'F' insulated and the maximum permissible temperature measured by contact thermometer should not exceed 160°C. In the event of non-availability of class 'F' insulated motors, class B/F insulated motors (class B for stator and class 'F' for the Rotor) with maximum permissible temperature measured by contact thermometer not exceeding 115°C and 130°C respectively may be offered.
- C1003.15 Other Features
- C1003.15.1 The terminal boxes should be large enough to accommodate Aluminium conductor cables which may have de-rating factor as low as 0.4 on account of high ambient temperature and grouping factor. The motors should be in IEC frame sizes. The terminal boxes should be located on top of the motor with facility to be rotated by 90° and 180° on horizontal plane.
- C1003.16 Control Panels
- C1003.16.1 All power and auxiliary contactors, etc. should be mounted in sheet steel cubicles with lockable hinged doors. The door hinges should be such that during repair works inside the panel, the entire door can be lifted out and placed away enabling better access inside the panel. Each motion should preferably have its individual panel. All ventilating openings should have screen protection. Interior of the panel should be dust and vermin proof.

- C1003.16.2 Panels should be front wired with readily accessible terminal blocks for making connection to the external equipment. All equipment is to be mounted in the front of the panel. Rear panel mounting is not permitted. All cable entry should be from bottom only. Removable plate is to be provided at the bottom of the panels for marking holes, providing cable gland for cables. Panels should be pre-wired up to terminal strip.
- C1003.16.3 All contactors etc. should be mounted securely in a vertical arrangement with due consideration to the vibration encountered in the operation of the crane. The bottom most row of equipment mounted inside the panel excepting terminal strip should be at least 350mm above the panel bottom cover to facilitate inspection and repair. Terminal strip should be fixed inside the panel preferably in horizontal manner leaving enough space underneath the panel for termination of cables in a convenient manner. Power and control terminals should be segregated. Power terminal blocks should be separated from each other by means of replaceable insulated spacers. Terminal blocks should have enough clearance to avoid tracking. At least 10% extra terminals in each of power and control groups must be provided. All equipment inside the panel should have permanent identification labels in accordance with circuit diagram as also the power and control terminals. Terminal blocks should be robust and of such construction as to preclude possibility of cable connections getting loose due to vibration on crane. Sheet steel used for fabrication of panel should have minimum thickness of 1.6mm. Panels should be mounted such that bottom of panel is at least 200 mm above the floor.
- C1003.16.4 Clearance and creepage distance for the control gear should be 10mm and 12mm respectively. The electrical clearance in air between all live parts of different polarity and voltage and between live parts and earth should be not less than 75mm.
- C1003.16.5 Contactor panels should be well braced to the crane structure and each panel should be provided with adequate number of lifting lugs.
- C1003.17 Contactors
- C1003.17.1 The current rating of all contactors should be at least 50% higher than the respective motor full load current at the specified duty cycle.
- C1003.17.2 The minimum size of contactors on the power circuit should be as given for high currents that may be encountered on account of single-phase brake lowering, plugging and DC injection as per the control scheme chosen.
- C1003.18 Electrical Interlocks
- C1003.18.1 An isolator fitted on the crane bridge which can not be operated from the Floor shall be provided to prevent inadvertent operation of the crane from the floor while maintenance work is being carried on the crane.
- C1003.18.2 Power supply (415V AC, 3 phase, 4 wire, 50 Hz) to the crane shall be provided by the Contractor at Centre of DSL (Down Shop Lead arrangement).
- C1003.19 Circuit Protective Switch Gear
- C1003.19.1 The protective switchgear should consist of following:

- (a) One triple- pole air circuit breaker, serving as main incoming protective switch fitted with automatic reset bimetal overload releases for protection against sustained overload and magnetic type instantaneous releases for protection under short circuit conditions, on all three phases.
- (b) The breaker should have adequate rupturing capacity to withstand and clear fault current of the order of 40KA. Further, the circuit breaker should have rating to carry combined full load current of two motions of the crane having largest horsepower. The setting of the over current release should be such as to trip the breaker instantaneously when current raises to 250% of the normal value. The incoming circuit breaker will be located inside driver cabin or nearby in such a way that enough clearance is provided as per IE rules.
- (c) To indicate whether power and control sources are ON, pilot LED indication lamps should be provided inside the driver's cabin.
- (d) In addition to incoming circuit breaker, following protective equipment should be provided inside the Driver's cabin.
- (e) MPCBs as appropriate to be used.
- (f) Complete panel must be fuse-less, except thyristor drives.

C1003.20 Auxiliary Switch Gear

C1003.20.1 A main iron clad pole isolating switch should be provided on the long travel bridge walkway as close as possible to the main current collectors. This switch should be without any fuse and of load isolating type. This should isolate all circuit except the lighting circuit, magnet circuits and the circuit to the transformer supplying the portable lighting socket outlets. Each of the above mentioned main isolating switches should be rated to carry at least combined full load current of two motions of crane having the largest horse powers and should be provided with means of locking the switch operating handle in the 'OFF' position. The switch cover should be interlocked with operating handle so that it cannot be removed or opened unless the operating handle is turned to the 'OFF' position. The live contacts inside the switch should be shielded to prevent accidental contact.

C1003.20.2 MPCBs are to be used. No fuses to be used.

C1003.21 Limit Switches

C1003.21.1 All hoist motions should be provided with rotary and extra Counterweight Limit Switch for over hoisting. For CT and LT, Cam operated limit switches should be provided. The limit switches should be provided for proper back up protection. The first limit switch to act in the event of over hoisting and over lowering, should be rotary type with self-resetting feature, and be incorporated in the control circuit of the respective drive motor and the second one should be gravity operated switch (Push button bypass) connected in the trip circuit of the Line Contactor. Limit switch incorporated in the motor control circuit should act first, but in case this limit switch fails to operate the second limit switch should operate and trip the line contactor.

C1003.22 Emergency Stop Push Buttons

- C1003.22.1 Safety switches of sustained contact type should be provided at the entrances to the crane bridge so that under any emergency conditions, operating any one of the switches, the incoming circuit breaker is tripped thus cutting off power to all the motions. Cabin door-interlocking switch, interlocked with the main incoming ACB should be provided. A pilot lamp incorporated in the control circuit will glow up when any of these switches is operated. Further a mushroom headed type OFF push button should be provided in the operator's cabin so that the main incoming breaker can be tripped under any emergency condition, by pressing the operating head.
- C1003.23 Control Characteristics
- C1003.23.1 The hoist control gear should be designed so as to limit control the accelerating torque/ current for hoisting with 185% of full load torque/current for changing the controller from one notch position to another higher notch position. Similarly, peak decelerating torque/current should be limited to 200% of full load value for changing the controller from highest position to the first lowering position. Bridge and trolley of the crane should have revising plugging control circuit for rapid deceleration and stopping. The control circuit should be designed such that the brakes provided should not come into action simultaneously with plugging.
- C1003.23.2 The control circuit should be designed such that the brakes provided should come into action immediately on controller coming to zero position.
- C1003.24 Brakes for Various Drives / Motors
- C1003.24.1 The brakes for various motion drives shall be as per the IS: 3177. The following type of brakes shall be provided for the various crane drives.
- (a) Bridge Travel
 - (i) Main braking by means of frequency speed control of motor down to 0 (regenerative braking).
 - (ii) Automatic DC electro-magnetic brake for each motor drive.
 - (iii) Double (2) brake discs + EHT.
 - (b) Trolley Travel
 - (i) Main braking by means of frequency speed control of motor down to 0 (regenerative braking).
 - (ii) Automatic DC electro-magnetic brake for each motor drive (DC Disc).
 - (iii) Double (2) brake discs + EHT.
 - (c) Hoisting Motion
 - (i) Main Hoist
 - Main braking by means of frequency speed control of motors down to 0 (regenerative breaking).
 - Automatic DC electro-magnetic brake (DC Disc).
 - Automatic electro hydraulic thrusters brake

(ii) Auxiliary Hoist

- Main braking by means of frequency speed control of motors down to 0 (regenerative braking).
- Automatic DC electro-magnetic brake (DC Disc).
- Automatic electro hydraulic thrusters brake

- C1003.24.2 The electromagnetic brakes shall be of DC type complete with rectifier equipment to convert the available AC 50Hz supply. The electro-hydraulic Thruster brakes shall be AC type.
- C1003.24.3 The operating solenoids of the EM DC brakes shall reverse the brakes on energization and shall automatically apply all the brakes immediately in the event of stoppage, interruption or failure of electrical power supply. The brakes shall also apply immediately in operating the emergency stop push button of switch irrespective of controller position.
- C1003.24.4 The EM DC brakes shall be of spring set shoe type equally effective in both directions of rotation. The springs for the EM brakes shall be of compression type and shall have adequate factor of safety.
- C1003.24.5 The brake system shall have the following provisions.
- (a) Locking device in the brake lever.
 - (b) Means for adjustment to compensate for wear of the shoes.
 - (c) Emergency stop push buttons.
- C1003.24.6 All the brakes shall have adequate capacity. The brakes for hoisting when applied shall arrest the motion and sustain the load up to the test load at any position of the lift. Provision shall be made to control with safety the lowering of any load up to the test load.
- C1003.24.7 Brakes in other motions shall be capable of bringing the relevant motions of the fully loaded crane safely to rest in the shortest possible time with least possible shock and shall arrest the motion under all other service conditions.
- C1003.24.8 The various brakes shall be designed to exert a torque equal to 1.5 times the full load torque of motors.
- C1003.24.9 The brake torque may be increased if considered necessary by the manufacturer in order to ensure proper and safe application of the brakes. All EM brake coils shall have continuous rating.
- C1003.25 Hoist Drive for Normal Speed
- C1003.25.1 The hoist shall be driven by a motor through speed reduction gear unit for normal speed of the hoist and shall be complete with brakes and retarding devices.
- C1003.25.2 The hoist shall have provision of Very slow, accurate and controlled operation by means of step less, frequency converter speed control system, enabling control of vertical motion of the hoist within 1 mm, will be required to place the generator rotor.
- C1003.26 Disposition of Electrical Equipment

- C1003.26.1 In case of fixed cabin cranes, the electric panels should be located as follows. For box girder cranes within the box if possible or on the walkway. In case equipment is located inside the box adequate lighting and ventilation should be provided.
- C1003.27 Lighting
- C1003.27.1 Lighting should be provided in the driver's cabin, staircases and areas where control panels, resistors and transformers are installed. Bulkhead fitting with dust proof covers should only be used for the above areas. Four number under bridge lights of 400 W LED lamp complete fitting with reflector to be used. Lighting transformers should have 50% reserve capacity. The lighting distribution board and metal clad switches incorporating MPCBs / MCBs / MCCBs in every line of each circuit should be provided in the driver's cabin for the Crane lighting including under bridge lighting and Air conditioning or fans.
- C1003.28 Socket Outlets
- C1003.28.1 Minimum of four socket outlets for hand lamps should be provided each at driver's cabin, long travel Side Bridge and in the area where control panels, resistors and transformers are installed. Hand lamps should operate at 24V AC supply. Industrial type metal clad plug and sockets should be provided.
- C1003.29 Cabling
- C1003.29.1 All wiring or power, control, lighting etc should be carried out with 1.1KV grade PVC armoured cables except flexible cables where armour should not be provided. All control cables should be minimum 2.5mm² Copper. All flexible cables should be multi-stranded copper. Single strand cables should not be used anywhere inside the crane. All cables exposed to direct heat radiation should be of special insulation or should be run in formed steel channels provided with heat resistant material. Cables laid on open racks should be adequately clamped.
- C1003.29.2 Cable selection and routing on the crane should form part of the crane design. Conduits and conduit fittings if used on crane for running cables should be of standard design and should be supplied with complete accessories. Each motor should be wired through separate conduits. All cables, remaining live in open position of isolator should be installed separately.
- C1003.29.3 Identification of Circuits / Cables Etc.
- C1003.29.4 Labels of permanent nature should be provided on supports of all switches, fuses, motors, brakes, contactors, relays etc. to facilitate identification of circuits and replacement. All panels, controllers, resistors etc. are to be properly marked for each motion. All power control cables, lighting and other cables are to be tagged at both ends as per cable number indicated in the supplier's drawing. All equipment terminals are also to be marked likewise.
- C1003.30 Safety Screen
- C1003.30.1 Safety screen should be provided with crane near the Down Shop Leads.
- C1003.31 Earthing

- C1003.31.1 Earthing to the crane should be effected through track rails and crane structure. As such, all the electrical equipment mounted on crane should be connected to the crane structure by means of earthing links. The crane structure in turn should be made electrically continuous by providing jumpers over riveted or bolted joints. Equipment fed by flexible cables should be earthed by means of spare core provided in the flexible cable.
- C1003.32 Automatic Electrical Protection
- C1003.32.1 The electrical equipment and circuitry shall be provided with automatic protection against various faults and mal-operation of the equipment as detailed below:
- C1003.32.2 Protective relays for protection against instantaneous over-current, over-load, single phasing and under voltage for all motors. The over current relay to be adjustable between 2 to 3 times the full load motor current.
- C1003.32.3 Protective relays of motors to trip the main power supply circuit breaker in case of their operation due to fault.
- C1003.32.4 MCCB's for control and protection of all motor circuits.
- C1003.32.5 Air circuit breaker located in operator's cabin, of 3-Pole, 415V, AC, totally enclosed type for power supply tapping from the main collectors, with interrupting capacity not less than 50 KA, and equipped with short circuit, over-load and under voltage trip devices, shunt trip coil, single phase prevention device, 3 timer relays and other necessary devices/ items.
- C1003.32.6 Protection against over speed of the hoist motors which shall cut off the power supply and apply the brake in case any hoist motor speed increases to 105% of the rated synchronous speed.
- C1003.32.7 Operation of any protective relays of motors shall trip the motor supply circuits.
- C1003.33 Inching Operation
- C1003.33.1 Inching operation for all motion shall be provided for the purpose of erection, lowering, centering, and alignment etc. of the generating units. The inching operation shall be achieved by VVVF control.
- C1003.34 Wiring
- C1003.34.1 All electrical wiring shall conform to latest revision of IS: 1554 (part-I) "PVC insulated (heavy duty) electric cables, for working voltage up to and including 1100 volts". All conductors for primary power, lighting and control circuits shall be stranded type and insulated for not less than 1100 Volts and shall have standard moisture resisting double braid coverings. All conductors between the secondary of the motor contactors and resistors shall have sufficient current carrying capacity in accordance with the standard specifications and shall be insulated with 1100 V class, high temperature type tropical insulation with moisture resisting impregnation. The primary conductors to the motors shall have standard, continuous current carrying capacity of not less than 100% of the rated full load primary current of the motor.

C1003.34.2 Only copper cables shall be used for power wiring. All control and lighting conductors shall be of copper and of suitable sizes. All the wiring shall be subject to approval of the Employer. All wiring shall be laid in hot dip galvanized metal conduits or laid on perforated cable trays or clipped on the crane structure by suitable device. Alternately armoured cables can be used. Conductor having nominal equivalent copper area of cross section less than 2.5 sq. mm shall not be used for wiring.

C1004 SPECIFIC DATA FOR EOT CRANES

C1004.1 A5-5T Single Girder EOT Cranes

1.	Safe Working Load	5 t
2.	Main Hoist Sate Working load	5 t
3.	Span	10 m
4.	Class of Duty	Class M5 as per 18 807/3177
5.	Operation	From Pendant Push Button control station.
6.	Location	Indoor, Nonhazardous atmosphere; 45°C Ambient temperature.
7.	Height of Lift	4 m
8.	Main Hoisting Speed	0.35/3.5 m/min and Micro motion through VFD
9.	Cross Travel Speed	2/20 m/min and Micro motion through VFD
10.	Long Travel Speed	2/20 m/min and Micro motion through VFD
11.	Main Hoist Motor Rating	4.5 kW
12.	Cross Travel Motor Rating	0.55kW x 1Nos
13.	Long Travel Motor Rating	0.43kW x 2Nos.
14.	Hoist. Cross Travel & Long Travel Motor Type	Squirrel cage, Crane Duty Motors, make ElectroMech for Hoisting & CT
15.	Long Travel Motor Type	Squirrel cage, Crane Duty Motors, make Bonfiglioli/equivalent

16.	Hoist, Cross Travel Brake Type	In built, electromechanical. conical rotor principal for Hoisting & Disc Brakes for CT
17.	Main Hoist Wire Rope Diameter	11 mm
18.	Main Hoist Number of Falls	4
19.	Wire Rope Construction	6 x 37, FMC, 1670 N/mm ² UTS, Ungalvanised
20.	All Wheels	Straight Tread, Dead Axle Execution
21.	Hooks	Single shank, Swivelling type
22.	CT Wheel Diameter	125mm x 4Nos.
23.	Long Travel Wheel Tread Diameter	160 mm
24.	Long Travel Wheel Load Without Impact	3.31 t
25.	Total Crane Weight	2.6 t
26.	Limit Switches (Hoisting / Cross Travel /Long Travel)	Included
27.	Long Travel Rails	50 x 40 Bright Bar - Recommended
28.	Power / Control Voltage	415V, 3 Phase, 50Hz / 110 V, 1Phase, 50 HZ ± 10%
29.	DSL System	100 Amps/ Gi Shrouded Bus Bar - Recommended
30.	Painting	1 coat of primer (Yellow Buff) and 1 coat of signal yellow colour (RAL 1003)

C1004.2 Details of crane to be furnished with the tender

S. No.	Description	Details to be filled
1.	Specification of the crane offered	
2.	Deviations, if any	

S. No.	Description	Details to be filled
3.	Time – Supply / E & C	
4.	Total weight of crane in MT	
4.1	Total wt. of crane (MT)	
4.2	Wt. of Trolley/Crab (MT)	
4.3	Wt. of each girder (MT)	
4.4	Wt. of each end carriage (MT)	
4.5	Wt. of cabin (MT)	
4.6	Wt. of electrical	
4.7	Wt. of platforms	
4.8	Wt. of LT drive	
4.9	Wt. of other components (specify the component name)	
Note: Total wt. of crane should match the other break-up weights.		
4.10	LT Wheel load (max / min)	
5.	Hoist: (Main & Auxiliary)	
	Speed in M/min	
	With maximum working load	
	With empty hook	
	Rope size and construction details	
	No. of rope falls supporting the load	
	Dia of Drum	
	Material of Drum	
	Material of Sheaves	

S. No.	Description	Details to be filled
	Lift of hook above floor level (exclusive of travel required to operate limit switch)	
	Drop of hook below floor level	
6.	Trolley	
	<u>Speed M/min with maximum load</u>	
	Wheel span	
	Material & Diameter of wheels	
	Size of trolley runway rails	
7.	Bridge	
	<u>Speed M/min with maximum working load</u>	
	Wheel base	
	Material & Diameter of wheels	
	Make, Type & Size of Bearings for gears	
	Number of wheels on each end of crane	
	Maximum wheel load & spacing	
	Clear width of foot walk	
8.	Make of Control,	
9.	Hook approach (MH)	
	<u>Cab end</u>	
	Opposite cab end	
	Distance between Main & Auxiliary hook	
10.	Distance centerline between girders to extreme outside of crane	

S. No.	Description	Details to be filled
	Cab side	
	Opposite cab side	
11.	Distance bottom of cabin to floor	
	Clearances	
	Bridge truck & building column	
	Trolley & roof chord	
12.	Maximum deflection of girders under maximum working load	
13.	Wiring trade name and classification of wire insulation	
14.	Make, Kw & NO of Motors MH AH CT LT	
15.	Make, Rating and configuration of VVVF drives	
16.	Make, Type & NO of Brakes MH AH CT LT	
17.	Make, Type & NO of Lt. Switch MH AH CT	

S. No.	Description	Details to be filled
	LT	
18.	Material of Gears / Pinion & Wheel, Type	
19.	Material of Gear Boxes	
20.	Radio Remote Control: Make, Type, Range, Provision for Siren, Lights etc.	

NOTE: If above clauses are found inadequate for furnishing all necessary information of the crane offered, the Contractor may append further information separately. Other information as per Annexure A of IS: 3177 may also be submitted, if asked for during approval process of vendor.

C1004.3 List of Approved Makes

- Electromech Material Handling Systems India Pvt Ltd.
- WMI Konecranes India Ltd.
- Anupam Industries Ltd.
- Hercules Hoist

C1100 ELEVATOR

C1101.1 Scope of Work

C1101.1.1 Contractor's scope of the contract shall comprise of providing equipment's, components, materials, labour, supervisory staff with infrastructure, T&P, scaffolding, consumables, testing, commissioning of the equipment, etc. required for completion of the work including O&M during DLP period. Contract Rates shall be deemed to be inclusive of all direct and indirect expenses required to be incurred as per this scope including but not restricted to the costs of the following.

S. No.	Description	No. of Passenger	Numbers
1.	Passenger Elevators (Office building)	8 Persons	1

C1101.2 Items of Work

C1101.2.1 Design, manufacture, supply, installation, testing and commissioning of Elevators including minor and incidental work to ensure complete and satisfactory completion.

C1101.3 Testing

C1101.3.1 Testing for the various items of equipment shall be performed at the contractor's cost and test certificate to be furnished by the contractor (for Motor, Machine Break-tests Controller & Steel wire Ropes). If required by the Employer, the Contractor shall permit the Employer's authorized representative to be present during any of the tests. After notification to the Employer that the installation has been completed the contractor shall make under the direction and in the presence of the Employer such test and inspections as have been specified or as the Employer shall consider necessary to determine whether or not the full intent of the requirements of the plans and specifications have been fulfilled. In case the work does not meet the full intent of the specifications and further tests shall be considered necessary the contractor shall be are all the expenses there of.

C1101.4 FATS (Factory Acceptance trials)

- All the FATS test shall be carried out at Vendors Premises and the certificate/ documents shall be handed over to the Employer/ Employer during his visit to the Vendors Site.
- The contractor has to furnish the Quality assurance plan (QAP) to the Employer/ Employer two (02) months in advance prior to the conduct of FATS.

C1101.5 Name Plates

C1101.5.1 Providing engraved anodized aluminium or approved equivalent name plates of suitable sizes on switchboards/panels/equipment's etc.

C1102 CIVIL WORKS, CLEANING AND PAINTING

C1102.1 Civil Works

C1102.1.1 All steel items required for installation and operation of Elevator System in Pits, Hoistways and Machine Rooms.

C1102.1.2 Minor civil work items required for the work like making chases in walls/ceilings, making holes and openings, providing inserts, grouting etc. including making good, RCC bed blocks for machine unit and RCC buffer block in the pit and painting the civil works.

C1102.2 Final Painting

C1102.2.1 Providing final paint coat to all exposed fabricated steel work and providing matching paint in approved manner over portions of factory painted equipment if damaged during transportation/storage/installation before handing over.

C1102.3 Site Clearance

C1102.3.1 Demobilization and clearing of all temporary works/ facilities after completion of work at site and cleaning work are before handing over.

C1102.4 Statutory approval

C1102.4.1 Obtaining approval from Elevator inspector and NOC for satisfactory installation of the Elevator system as also for clearance to put the Elevator into regular use.

C1102.4.2 Obtaining any other statutory permission/clearance/approval from Bureau of Indian standard, Electricity Act, 2003 (Central Act 36 of 2003) and any rules or Regulations made there under including National Electrical Code, National Building Code or specifications of International Electro-Technical Commission.

C1102.4.3 Pay any licensing fee/submission fee/inspection fee payable to statutory authorities for obtaining above approvals.

C1102.4.4 All actual fees payable in this regard will be reimbursed against receipt I documentary proof on completion of work.

C1102.4.5 Local laws (if any)

C1102.5 Compliance of statutory observation

C1102.5.1 Complying with observations, if any, of Elevator/ Electrical Inspector and/or any other Statutory Authority after completion of work in order to obtain a categorical clearance to start beneficial use.

C1103 MANUALS, DRAWINGS ETC.

C1103.1 Along with the Tender

C1103.1.1 Technical Parameters enclosed as Annexure-1 duly filled in by the Tenderers along with technical catalogue etc. of the equipment offered.

C1103.1.2 Shop drawings on award of work before commencement

C1103.1.3 The Contractor shall submit GA drawings of Elevator System to Employers/Employer for approval before commencement of work at site/fabrication/ manufacture.

- C1103.2 Operation and Maintenance Manuals
- C1103.2.1 Three copies of Operation & Maintenance Manual, safety provisions, photographs, schematic diagram, Manufacturers list of recommended spares, PIL (Part identification list) etc. should be provided. A set of CD's containing the documents / information recorded on it should also be provided.
- C1103.3 Training
- C1103.3.1 Training of Employers personnel in operation, handling and maintenance of equipment. A training session shall be provided to at least four persons from for the Elevator operating personnel and maintenance department. The training shall outline Elevator operation, troubleshooting, and repair guidelines.
- C1103.3.2 The Contractor shall submit following documents
- 3 sets of operation and maintenance manual with support drawings shall be submitted to the Employer after completion of work.
 - 3 sets of test results of pre-commissioning test carried out at site.
 - 3 sets of as built GA drawings.

C1104 MAINTENANCE PERIODS

- C1104.1 Maintenance
- C1104.1.1 Quoted rates shall be deemed to be inclusive of, maintenance (including spares) of Elevators for a period of two years from the date of Handing over. Manufacturers list of recommended spares, PIL (Part identification list) and details etc. should be provided along with the Tender document.
- C1104.2 Taking Over of Installation
- C1104.2.1 The equipment & installation shall be deemed to have been taken over by the Employer, when the following are completed.
- C1104.2.2 Employer have certified that all contractual obligations have been fulfilled by the Contractor.
- C1104.2.3 All performance tests shall be carried out and Test Certificates shall be furnished by the contractor.
- C1104.2.4 The taking over of the installation shall be deemed to be complete, only when the contractor has carried out all tests in the presence of the Employer and when the contractor has submitted the 'As Built' Drawings. The installation is approved by the Elevator inspectorate.
- C1104.2.5 Guarantee shall be provided for 24 months after the date of handing over after taking over certificate of the project. Test reports will be handed over with Elevator during commissioning.
- C1104.3 Completion Certificate

- C1104.3.1 On completion of the Elevator installation a certificate shall be furnished by the Contractor countersigned by the licensed Supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority. The Contractor shall be responsible for getting the electrical installation inspected and approved by the local and statutory authorities concerned and expenses if any shall be borne by the contractor.
- C1104.4 Training of Operating Staff
- C1104.4.1 The Contractor shall arrange for train of Project Manager's operating staff in the correct operation of all important equipment's in this contract as directed by Project Manager. The Contractor shall also familiarize the operating staff during the erection period with the design, construction and all maintenance aspects of the equipment.
- C1104.5 Standards
- C1104.5.1 The following Indian Standard Specifications and Codes of Practice, currently applicable and updated as of date irrespective of dates given below, shall apply to the equipment's and the work covered by this contract. In addition the relevant clauses of the Indian Electricity Act 1910 as amended up to date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

1.	Code of Practice for installation, operation and maintenance of electric passenger & goods s.	IS-14665 (Part 2) Sec-1: 2000
2.	Code of practice for installation, operation and maintenance of electric.	IS-14665 (Part 2) Sec-2: 2000
3.	Safety Rules Section-1 Passenger and Goods	IS-14665 (Part 3) Sec-1: 2000
4.	Safety Rules Section-2 -	IS-14665 (Part 3) Sec-2: 2000
5.	Outline dimension for electric s.	IS-14665 (Part-1): 2000
6.	Inspection Manual for Electric s	IS-14665 (Part 5): 1999
7.	Electric Traction s – Components	IS-14665 (Part 4) Sec-1 to 9: 2001
8.	Installation and Maintenance of s For Handicapped Persons (Code of Practice)	IS 15330 :2003
9.	Specification for s cables.	IS-4289 (Par-1): 1984 Reaffirmed 1991
10.	Specification for hot rolled and slit steel tee bars.	IS—1 173—1978 Reaffirmed 1987
11.	Method of loading rating of worm gear.	IS-7443-1974

		Reaffirmed 1991
12.	Code of practice for selection of standard worn and helical gear box.	IS-7403-1974 Reaffirmed 1991
13.	Isometrics screw threads.	IS-4218-(Part-11)1976 Reaffirmed 1996
14.	Degree of protection provided by enclosure for low voltage switchgear and control gear.	IS-2147-1962
15.	Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service.	IS-1271-1985 Reaffirmed 1990
16.	Code of practice for earthing.	IS-3043-1987
17.	Electrical installation Fire Safety of Building.	IS-1646-1997
18.	PVC insulated electric cable for working voltage upto and including 1100 volts.	IS-694-1990
19.	Code of practice for electrical wiring and installation	IS-732-1 989
20.	PVC insulated (Heavy Duty) electric cables for working voltage upto and including 1100 volts.	IS-1554-1988 (Part-1)
21.	Flexible steel conduits	IS-3480-1966
22.	Accessories for rigid steel conduit for electrical wiring	IS-3837-1976
23.	Boxes for the enclosure of electrical accessories	IS-5133-1969 (Part-1)
24.	Guide for safety procedures and practices in electrical work.	IS-5216-1982 (Part-1)
25.	Conductors for insulated electric cables and flexible cordes	IS-8130-1984
26.	Miniature Circuit Breakers	IS-8828-1996
27.	Rigid steel conduits for electrical wiring (Second revisions)	IS-9537-1981
28.	Methods of test for cables	IS-10810-1998
29.	Earth Leakage Circuit Breakers.	IS-12640-1988
30.	Moulded Case Circuit Breakers	IS-13947-1993
31.	General requirement for switchgear and control gear for voltage not exceeding	IS-13947-1993

	1000 volts.	
32.	1100 volt grade XLPE insulated armoured cables	IS 7098
33.	Specifications for hoist way door-locks	IS 7754-1975
34.	Rules for design, installation, testing and operation of Elevators, escalators and moving parts.	IS 1735-1975

C1104.5.2 In addition, the relevant clauses of the following, as amended up to date shall apply.

- Bureau of Indian Standard
- The Indian Electricity Act 2003 (Central Act 36 of 2003)
- National Electrical Code
- National Building Code
- Specifications of International Electro- Technical Commission
- Local Laws (if any)

C1104.5.3 The tenderers shall also take into account local and State regulations as in vogue for the design and installation of Elevators.

C1104.5.4 Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable. BIS certified equipment shall be used as a part of the Contract.

C1104.6 Electric Supply

C1104.6.1 The available system of electric supply is 415 volts +10% -20%, -3 phase 4 wire AC 50 Hz system and 240 volts between phase and neutral. Any equipment /component operating at other than the above mentioned power supply shall be provided with necessary transformers/voltage stabilizers. The amount of power required for Elevators shall be indicated in the tender. Power shall be provided at one point to be indicated by the tenderer. All subsequent electrical systems shall be deemed to be included in the scope of this contract.

C1105 ELEVATOR- MACHINE AND CONTROLLER

C1105.1 General Requirements

C1105.1.1 The Elevators shall include all elements conforming to specifications or as amended herein. Elevators covered by these specifications shall be provided, installed, tested, commissioned, certified and approved as per statutory requirements of Elevator Inspectorate.

C1105.1.2 Each Elevator shall have its own driving machine. The method of drive shall be Electric Traction with Gear less motor having VVVF Control.

C1105.1.3 The design of the Elevators shall take into consideration fire prevention, elimination of dust and dirt traps, and easy accessibility for cleaning and routine maintenance.

C1106 ELECTRIC TRACTION DRIVE SYSTEM

C1106.1 Traction Machine

C1106.1.1 The construction of all Elevator machines shall conform with IS-14665

C1106.2 AC Motor (Elevator with machine room)

C1106.2.1 The AC self-lubricating motor shall be suitable for Elevator use with high starting torque and low starting current. Thermistors shall be embedded in the stator windings to indicate the temperature rise in the motor. The A C motor shall have Class F insulation and suitable for not less than 180 starts per hour with a maximum temperature rise of 50 degree Cover the ambient.

C1106.3 Brake

C1106.3.1 The Electro-magnetic brake with non-asbestos lining shall be spring applied and electrically released type having noise less operation.

C1106.3.2 The brake shall be capable of stopping and holding the Elevator car in its downward travel to rest with 125% of its rated load from the maximum governor tripping speed. In this condition the retardation of the Car shall not exceed that resulting from the operation of the Safety gear or stopping on the buffer.

C1106.3.3 Springs used to apply the brake shoes (two nos.) shall be in compression and adequately supported.

C1106.3.4 Brake linings shall be of renewable incombustible materials and shall be secured to the brake shoes such that normal wear shall not weaken their fixings. Band brakes shall not be used.

C1106.3.5 No earth fault, short circuit or residual magnetism shall prevent the brake from being applied in the event of loss of power supply to the Elevator motor and control circuit.

C1106.3.6 A means of adjusting the brake plunger stroke and releasing the brake in emergency shall be provided.

C1106.3.7 The Elevator machine shall be fitted with a manual emergency device capable of having the brake released by hand and requiring a constant effort to keep the brake open.

C1106.3.8 The fail safe break shall incorporate an approved design of brake switch i.e. pick up, hold, discharge. Brake coil shall be wired in series & their respective switches in parallel. The operation of brake shall be thyristor controlled from solid state drive in order to effect minimum pick up time and synchronized start.

C1107 DRIVINGMECHANISM

C1107.1 Elevator Machine

C1107.1.1 The Elevator machine shall be suitable for 415 volts, 3 phase 50 Hz AC supply with a voltage variation of +10% and -20% and shall be placed directly above the hoist way on steel beams resting on machine room floor slab.

C1107.1.2 The Elevator machine shall have high efficiency and low power consumption and shall be designed to withstand peak currents in Elevator duties.

C1107.1.3 Means for manual operation of the Elevator car shall be made by providing winding wheel suitably marked to indicate the direction of the movement to enable the Elevator car to be brought to the nearest landing. There shall be a warning display for switching *off* electrical supply before the manual operations.

C1107.2 Driving Sheaves

C1107.2.1 The sheaves shall be manufactured in steel or SG iron and fitted with sealed for life lubricated bearings.

C1107.2.2 The sheaves shall have machined rope grooves that can be reworked for future wear.

C1107.2.3 Adequate provision shall be made to prevent any suspension ropes leaving groove due to rope slack or introduction of foreign objects.

C1107.3 Alignment

C1107.3.1 The brake plunger, collar, sleeve, motor, sheaves and all bearings shall be mounted and assembled so that proper alignment of these parts is maintained.

C1107.3.2 The assembly shall be reviewed and rectified when excessive noise is emitted during operation.

C1107.4 Gearless Machines

C1107.4.1 The gearless machine shall consist of a motor traction sheave and brake drum or brake disc completely aligned on a single shaft. Gearless machine shall be AC gearless with VWF drive.

C1107.5 Anti-Vibration Supports

C1107.5.1 The whole traction machine shall be mounted on appropriate anti-vibration supports to minimize noise and vibration.

C1108 CONTROL SYSTEMS

C1108.1 Description

C1108.1.1 The Elevators shall have state of art microprocessor based AC variable voltage variable frequency (ACVWF) drive. Single Elevators shall be provided with directional collective control for one car, two cars and 5 cars (also called simplex, duplex full collective control and automatic group supervisory control). The control system shall regulate dispatching of individual cars and shall provide service to all floors as different traffic conditions arise minimizing unproductive factors. The system shall respond automatically to UP and DOWN peak, balanced or light traffic etc. Some of the technical parameters required are in numerate below.

(a)	Starting current	1.2 - 1.5 times full load running current
(b)	Power saving	50 - 55%
(c)	Levelling accuracy	± 3 mm (passenger/ Freight cum Passenger Elevator) & ± 5mm(Freight Elevator)
(d)	Acceptable voltage fluctuation	+ 10 to - 20%
(e)	Rate of acceleration/deceleration (M/S ²)	0.6 - 1.5 (Adjustable at site)
(f)	Maximum jerk (MIS3)	0.7 - 1.5 (Adjustable at site)
(g)	Maximum vibration in car horizontal/ vertical	20/18 dBA
(h)	Maximum noise level in car during travel	45 dBA
(i)	Maximum door noise level while closing and opening at a distance of 1 mtr from car door	52dBA

C1108.1.2 The controller shall be mounted on the side of the top of Elevator shaft, vertical, totally enclosed cubicle type with hinged doors on the front provide easy access to all components in the controller. Cubicle shall be well ventilated such that the temperature inside never exceeds the safe limits of the components at ambient room conditions.

C1108.1.3 The controller shall operate within the supply voltage variation of plus 10% to minus 20% of the nominal voltage.

- C1108.1.4 The Controller shall be including protection against the following abnormalities and shall cut off the power supply, apply the brake and bring the car to a rest in the event of any of the abnormalities occurring.
- (a) Overcurrent
 - (b) Under voltage
 - (c) Overvoltage
 - (d) Single phasing
 - (e) Phase reversal
 - (f) Earth leakage
 - (g) Short circuit protection
- C1108.2 Features
- C1108.2.1 Control system features are detailed as below.
- C1108.3 Attendant Operation
- C1108.3.1 All Elevators shall be provided with attendant control facilities.
- C1108.3.2 A key switch for change of operation mode shall be provided in a lockable recess panel on the car operation panel. After gaining control on the Elevator, the attendant can direct the car to stop at any story. The attendant can also by pass the landing calls (but not cancel them) or reverse the direction of traveling.
- C1108.4 Automatic By-pass
- C1108.4.1 Load weighing devices located either on car top or under the car cage shall be provided for all Elevators. Whenever the load exceeds 60-70% of the capacity load of the Elevators, the Elevators shall ignore all landing calls and only respond to car calls.
- C1108.5 Over Load Device
- C1108.5.1 A load weighing devices shall operate when the load in the car exceeds the rated capacity. The operation of the device shall activate buzzer sound and flashing 'overload' signals. At the same time the car doors shall be prevented from closing. When the excess load has been removed from the car, the buzzer alarm shall be muted automatically and the car shall function normally. The sensitivity shall be 30 kg for Passenger Elevators and 5% of the contract load for Freight cum Passenger Elevator.
- C1108.6 Automatic Self-Leveling
- C1108.6.1 All Elevators shall be provided with automatic self-leveling feature that shall bring the Elevator car level to within $\pm 3\text{mm}$ for passenger/Freight cum Passenger Elevator and $\pm 5\text{mm}$ for freight elevators of the landing floor regardless of load or direction of travel. The automatic self-leveling feature shall correct for over travel and rope stretch.
- C1108.7 Automatic Rescue Device
- C1108.7.1 The ARD shall have the following specifications.

- (a) ARD should move the elevator to the nearest landing in case of power failure during normal operation of elevator.
- (b) ARD should monitor the normal power supply in the main controller and shall activate rescue operation within 10 second of normal power supply failure. It should bring the elevator to the nearest floor at a slower speed than the normal run. While proceeding to the nearest floor the elevator will detect the zone and stop. After the elevator has stopped, it automatically opens the doors and parks with door open. After the operation is completed by the ARD the elevator is automatically switched over to normal operation as soon as normal power supply resumes.
- (c) In case the normal supply resumes during ARD in operation the elevator will continue to run in ARD mode until it reaches the nearest landing and the doors are fully opened. If normal power supply resumes when the elevator is at the landing, it will automatically be switched to normal power operation.
- (d) All the Elevator safeties shall remain active during the ARD mode of operation
- (e) The battery capacity should be adequate so as to operate the ARD at least seven times a day provided the duration between usage is at least 30 minutes.

C1109 ELEVATOR - CAR, DOORS AND SAFETY DEVICES

C1109.1 Car Enclosures

C1109.2 General Requirements

C1109.3 Frame

C1109.3.1 Every Elevator car body shall be carried in a steel car frame assembly which shall have sufficient mechanical strength to resist the forces applied by the safety gear or impact of the car on the buffers. The deflection of the steel members carrying the platform shall not exceed 1/1000 of their span under static conditions when the rated load is evenly distributed on the platform

C1109.3.2 At least four renewable guide shoes or shoes with renewable linings or sets of guides rollers shall be provided two at the top and two at the top and two at the bottom of the car frame assembly.

C1109.4 Enclosure Finishes

C1109.4.1 The car enclosure, doors etc. shall be as per Table 1, 2 & 3 enclosed. The following are to be provided.

- Alarm System: An emergency alarm buzzer, including wiring shall be provided and connected to a plainly marked push button in the car operating panel. The alarm bell shall be located in central security room. The alarm unit shall be solid-state siren type, to give a waxing and waning siren when the alarm button in the car is pressed momentarily. Built in 3 way intercom system with telephone instrument in the car, operator's room and security, (as directed by Employers/Employer) including wiring telephone instrument and associated EPABX shall be provided.
- Sealed Maintenance Free Nickel Cadmium Batteries capable of maintaining the following in each Elevator for 2 hrs after mains failure.
 - Emergency light of adequate illumination in car
 - Car Ventilation
 - Intercommunication System
 - Alarm bell
- One no. 16 amp switch socket outlet to IP 54 and a permanent weather proof type luminaries to IP54 (with lighting switch) adequately protected shall be provided on the top of the Elevator car for maintenance.
- One no. 16 amp switch socket outlet to IP 54 at bottom of Elevator car for maintenance.

C1109.5 Operation Panel

C1109.5.1 A full length car operating panel incorporating following control/indications shall be provided in each Elevator on the return panel.

- LED Illuminated touch push buttons of micro pressure type corresponding to the floors served
- Door open and door close button
- Emergency stop button with Alarm
- Two position key operated switch for 'with attendant' and 'without attendant' operation.
- Ventilation fan ON/OFF switch with auto OFF when there is no call after 120 seconds (Two Speed & concealed vents).
- Built in intercom of the hands free type as well as space for providing EPABX telephone instrument and 5 pair telephone trailing cable to communicate from car to Two Locations i.e. Operator's Room (at remote location) & Security Guard Room and vice-versa.
- Dynamic car direction display
- Car position indicator(digital)
- Audio/Visual overload warning indicator

- In order to have at least one device of communication functioning at all the times, as an alternative arrangement, it is recommended that the provision of both i.e. telephone with minimum connections- one at the operator's room and other at guard room and the emergency signal with re-chargeable batteries as source of supply be made in the Elevator cars.
- The device used for emergency signals should incorporate a feature that gives a immediate feedback to the car passengers that the device has worked properly and the signal has been passed onto the intended agency.
- Digital voice synthesizer (Optional) for announcing special messages with background music.

C1109.6 Landing Fixture

C1109.6.1 The landing fixtures shall be recess mounted on a base junction box in the wall by the side or on top of landing doors as required.

C1109.6.2 Each landing fixtures shall consist of micro touch type landing call buttons with illuminated call acknowledge signal and illuminated digital type car position indicators on separate stainless steel face panels with hairline finish. Alternatives as available with bidders shall be indicated in tender for Employers approval.

C1109.6.3 The following landing fixtures shall be provided for each Elevator.

a) Lowest floor

- Up call button
- Digital car position indicators
- Travel direction indicators
- "In use" indicator to signify the Elevator door is opened for delivery at a certain landing

b) All floors other than lowest and top most floor

- Button up and down call buttons
- Travel direction indicators
- Digital car position indicators with Gong (Optional)
- "In use" indicators to signify the Elevator door is opened for delivery at a certain landing
- Manual by pass key switch for Elevator landings.

c) The top most floor

- Down call button
- Travel direction indicators

- Digital car position indicators with Gong(Optional)
- "In use" indicators to signify the Elevator door is opened for delivery at a certain landing
- Manual by pass key switch for Elevator landings.

C1110 CAR AND LANDING DOORS

C1110.1 General Requirements

C1110.1.1 All car doors shall extend to the full height and width of landing opening unless otherwise specified and shall be operated with variable frequency door operator. A similar imperforate door shall be provided for every landing opening in the Elevator hoist way enclosure. The top track of the landing and car doors shall not obstruct the entrance to the Elevator cars. All car and landing doors shall have a fire resistance of not less than 1 hours.

C1110.1.2 In addition, all the car and landing doors shall meet the following general requirements.

C1110.2 Car Door Locking Devices

C1110.2.1 Every car door shall be provided with an electrical switch to prevent the Elevator car from being started or kept in motion unless the car door is closed. A mechanical locking device shall also be provided to prevent door opening from inside the car whilst the car is in motion.

C1110.3 Landing Door Locking Devices

C1110.3.1 Every landing door shall be provided with a mechanical locking device to prevent opening of the door from the landing side in normal cases unless the Elevator car is in that particular landing zone.

C1110.4 Projections and Recesses

C1110.4.1 Sliding car and landing doors shall be guided on door tracks and sills for the full travel of the doors. The distance between the cars and the landing sills shall not exceed 35 mm.

C1110.5 Door Locking Devices

C1110.5.1 All doors locking devices, door switches and associated actuating rods, levers or contracts, shall be inaccessible from the landing or the car.

C1110.6 Protective Devices

C1110.6.1 Protective devices shall be fitted to the leading edges of both car door panels. It shall automatically initiate reopening of the door in the event of a passenger being struck (or about to be struck) by the door in crossing the entrance during the closing movement. The obstruction of either leading edge when closing shall actuate the protective device to function.

C1110.7 "Door Open" Alarm

C1110.7.1 "Door open" alarm shall be provided in the car to initiate alarm and a continuous buzzer if a car or landing door has been mechanically kept open for a present period. The period shall be adjustable from 0-10minute.

- C1110.8 Emergency Landing Door Unlocking Devices and Key
- C1110.8.1 Every landing door shall be provided with an emergency landing door unlocking device. When operated by an authorized person with the aid of a key to fit the unlocking triangle, the landing door shall be unlocked irrespective of the position of the Elevator car for rescue purpose. When there is no "unlocking" action, the key shall only be able to stay in the locked position.
- C1110.8.2 In the case of coupled car and landing doors, the landing doors shall be automatically closed by means of weight or springs when the car is outside the unlocking zone.
- C1110.9 Door Hangers and Tracks
- C1110.9.1 The car and the landing doors shall be provided with two point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be steel with moulded nylon collar and shall include shielded ball bearings. Tracks shall be of suitable steel section with smooth surface. The landing doors shall be complete with headers, sills, frames etc. as required.
- C1110.10 Elevator Door Protection
- C1110.10.1 Multiple-Infra red door protection and mechanical shoes shall be provided for all Elevator to control door movement which shall cover the entire door opening effectively.
- C1110.10.2 Protective Hand Rail in the Car (Optional as this will depend on interior design)
- C1110.11 Hoist Ropes
- C1110.11.1 Hoist way material shall be non-flammable (02 hrs fire rated) except travelling cables which shall be flame resistant.
- C1110.12 Elevator Ropes -1514665 (Part 4 / Sec 8)-2001
- C1110.12.1 Round strand steel wires ropes made from steel wire ropes having a tensile strength not less than 12.5 tonnes/cm² and of good flexibility shall be used for Elevator. Lubrications between the strands shall be achieved by providing impregnated hemp core. The Elevator ropes shall conform to IS 14665-(Part-4-Sec. 8):2001 and the following factor of safety shall be adhered to. The minimum diameter of rope for cars and counter weight of passenger and goods Elevator shall be 8mm.

Rope speed of Passenger & Passenger cum Goods Elevators (Freight cum Passenger Elevator) (m/s)	Factor of safeties
0.5 or less	8
exceeding 0.5 to 1.0	8.6
exceeding 1.0 to 2.0	10
exceeding 2.0 to 3.5	11
exceeding 3.5	12

C1110.13 Rope Fastenings

C1110.13.1 The ends of Elevator ropes shall be properly secured to the car and counter weight hitch plates as the case may be with adjustable rope shackles having individual tapers babbit sockets, or any other suitable arrangement. Each Elevator rope shackle shall be fitted with a suitable shackle spring; seat washer, shackle nut & lock & shackle nut split pin.

C1110.14 Guards for Elevator Ropes

C1110.14.1 Where Elevator ropes run round a sheave or sheaves on the car and/ or counterweight of geared/ gearless machine suitable guards shall be provided to prevent injury to maintenance personnel.

C1110.15 Number & Size of Ropes

C1110.15.1 The contractor must indicate the number and size of Elevator ropes and governor ropes proposed to be used, their origin, type, ultimate strength and factor of safety. The contractor should furnish certificate or ropes from the rope manufacturers issued by competent authority.

C1110.16 Counter Weight

C1110.16.1 The counter weight for Elevator cars shall be in accordance with clause 6 of IS 14665 (Part 4-Sec-3): 2001 and shall be designed to balance the weight of empty Elevator car plus approximately 50 percent of the rated load. It shall consist of cast sections firmly secured in relative movement by at least two numbers steel tie rods having lock nuts/split pins at each end and passing through each section and Housed in a rigid steel frame work. Cracked and broken sub weights shall not be accepted. Counter weight for passenger Elevators should be able to accommodate approx. 500 kg weight Interior finishes. In case interior finishes material exceeds this provision, then the elevator contractor shall adjust the Counter Weight accordingly, however this will be decided and intimated much before the delivery of the elevators.

C1110.17 Counter Weight Guards

C1110.17.1 Guards of wire metal / mesh shall be provided in the Elevator pit to a suitable height above the pit floor to eliminate the possibility of injuries to the maintenance personnel.

C1110.18 Guides/ Guide Rails

C1110.18.1 Car and counterweight guide shall be machined T section as per relevant Indian Standards IS- 14665 of 2000 revised up to date. The guides shall be capable of withstanding forces resulting from the application of the car or counter weight safety devices. The guide rails shall be minimum 16mm Tongued & Grooved type.

C1110.19 Trailing Cables

C1110.19.1 A single trailing cable for lighting control and signal circuit is permitted, if all the conductors of this trailing cables are insulated for maximum voltage running through any one conductor of this cable. The lengths of the cables shall be adequate to prevent any strain due to movement of the car. All cables shall be properly tagged by metallic / plastic tags for identification. Cable jacket should be suitable for immersion in water, salt water & oil etc.

- C1110.19.2 Trailing cables shall run from a junction box on the top of the car to a junction box located in the shaft bear mid-point of travel and from these junction boxes conductors shall be run to the various locations.
- C1110.19.3 Trailing cables exceeding 30 meters in length shall run so that the strain on individual cable conductors will be reduced to a minimum and the cables are free from contact with the car counterweight, shaft walls or other equipment.
- C1110.19.4 Trailing cables exceeding 30 meters in length shall have steel supporting fillers and shall be suspended directly by them without rubbing over other supports.
- C1110.19.5 Cables less than 30 meters in length shall have no - metallic fillers and shall be suspended by looping cables around supports of porcelain spools type or equivalent.
- C1110.19.6 5 percent of the total capacity subject to a minimum of 5 wires shall be available unutilized in the trailing cable everywhere suitable distributed between various functions.
- C1110.20 Safety Devices
- C1110.20.1 Safety devices shall be capable of operating only in the downward direction and stopping fully loaded car, at the tripping speed of the over speed governor, even if the suspension devices break, by gripping the guides, and holding the car there. Governor she eve in elevator pit shall be enclosed in a wire cage to a height of 2.40 mtr. All safety devises statutorily required by Elevator Inspector, including but not restricted to the following shall be provided.
- C1110.21 Terminal Slow Down Switches
- C1110.21.1 These shall be provided and installed to slow down the Elevator car when approaching the top and bottom landings. The slow down switches shall act independently from the normal car operating device.
- C1110.22 Over Travel Limit Switches
- C1110.22.1 These shall be provided and installed to stop the car within the top and bottom clearance, independent of the normal car operating device. The bottom over travel limit switch shall become operative when the bottom of the car touches the buffer.
- C1110.22.2 When the over travel limits witches are operative, it shall be impossible to operate the car until the car has been hand would to a position within the normal travel limits.
- C1110.23 Pit Switch
- C1110.23.1 An emergency stop switch shall be located in the pit which when operated shall stop the car regardless of the position of hoist way.
- C1110.24 Terminal Buffers

- C1110.24.1 Suitable spring buffers mounted on RCC foundation blocks shall be provided in the pit in compliance with ANSI/ASME/CENEN-81 /JIS codes for stopping the car in case of mal-operation. Dowels for the purpose shall be left while casting the pit floor alternatively floor reinforcement could be exposed by chipping for welding additional reinforcement for Dowels. However, clearance from underside of the car resting on a fully compressed buffer shall not be less than 1.20 m. Buffers shall be designed for a design speed + 15%. Oil buffers shall be provided for the passenger elevators for speed of more than 1.75 m/s and spring buffers for lower speed.
- C1110.25 Interlocking
- C1110.25.1 Adequate interlocking is to be provided so that the car shall not move if the landing doors are even partially open and also the Elevator is overloaded.
- C1110.26 Over Speed Governor
- C1110.26.1 Over speed governor shall be of centrifugal type and shall operate the safety gear at a speed at least equal to 115% of the rate speed and less than the over speed governors shall be driven by flexible wire ropes with the following requirements.
- C1110.26.2 The breaking load of ropes shall be related to the force required to operate the safety gear by the safety factor of at least 8.
- C1110.26.3 The nominal rope diameter shall be at least 7 mm.
- C1110.26.4 The ratio between the pitch diameter of the over speed governor pulley and the nominal rope diameter shall be at least 30.
- C1110.26.5 The over speed governors shall be sealed after setting the tripping speed.
- C1110.26.6 The breaking or slackening of the governor rope shall cause the motor to stop by an electric safety device.
- C1110.27 Alarm Bells
- C1110.27.1 A Concealed 200 mm diameter alarm bell shall be installed in the main security area. The alarm bell shall sound when the alarm bell button in the car operating panel is pressed. The bell shall mute when the pressure on the alarm bell button is released.
- C1110.28 Emergency Stop Switches
- C1110.28.1 An emergency stop for use by maintenance personal shall be provided in each Elevator car.
- C1110.29 Fireman Switch
- C1110.29.1 Each Elevator shall have a Fireman switch with glass front for access by the Firemen. The operation of this switch shall cancel all calls to this Elevator and shall stop at the next nearest landing if traveling upwards. The doors shall not open at this landing and the Elevator shall return to the ground floor. In case the Elevator is traveling downwards when the fireman's switch is operated it shall go straight to the ground floor by passing all call sen route. The emergency stop but ton inside the cars hall be rendered in operative.

- C1110.29.2 The fireman's switch shall be located adjacent to the Elevator opening at the terminal floor and shall be at a height of approximately 2 m above the floor level. For easy identification of firemen's Elevator which confirm to the local authorities requirements, a red and white diagonal striped backing shall be provided behind the glass of the firemen's switch.
- C1110.29.3 A permanent notice of prominent size indicating the floors served shall be provided and displayed adjacent to the firemen's Elevator at the terminal floor. The notice shall be made of laminated plastic sheet or other approved materials with red letters on white background. Details of the notice shall be submitted to the Employer for approval prior to fabrication.

C1111 CONTROL OF NOISE AND VIBRATION

C1111.1 General

- C1111.1.1 The whole of the Elevator assembly, including the opening and closing of the car and landing doors shall be quiet in operation and shall be free of rattling or squeaking noises. Elevator doors operation shall be smooth to avoid the transmission of impact noise to the surrounding structure.
- C1111.1.2 Noise level resulting from the operation of the Elevators, including direct sound transmission, breakout noise and re-radiation of structure borne noise, shall not exceed the specified noise criteria of the adjacent spaces. Vibration resulting from operation of Elevators of escalators shall not be perceptible in any occupied areas.

C1111.2 Car Construction

- C1111.2.1 All elements of the Elevator car construction shall be sufficiently rigid to avoid generation of noise by panel excitation as a result of movement. The total noise level in a moving Elevator car shall not exceed 45 dBA with the ventilation system operating.

C1111.3 Machinery

- C1111.3.1 The gearless traction machine and compact PM motor are installed within the hoist way and the slim control panel is located on the shaft side wall. Provision shall be made for the control vibration isolation measures employed to ensure that structure borne noise resulting from the operation of the Elevator machinery is not audible in any occupied area.
- C1111.3.2 Elevator machinery noise levels under normal operating conditions shall not exceed 70 dBA at 1 m from the equipment in free field. The contractor has to submit all the relevant certificates to satisfy the specification.

C1111.4 Arrival chimes

- C1111.4.1 Noise from arrival chimes shall not exceed 60 dBA.
- C1111.4.2 The above levels shall be measured at 3 m from the arrival chimes using a noise meter set to 'fast' response. Chimes with adjustable loudness shall be provided.

C1111.5 Fire Safety Requirements

- C1111.5.1 General requirements of Elevators shall be as follows:

- Landing doors in Elevator enclosures shall have a fire resistance of not less than two hour.
- Elevator car door shall have a fire resistance rating of two hour.
- Grounding switch(es), at ground floor level, shall be provided on all the Elevators to enable the fire services to ground the Elevators.

C1112 ASSOCIATED WORKS

C1112.1 Associated Electrical Works

C1112.2 Scope

C1112.2.1 Based on power requirements of Elevators, power supply for the Elevators machines, terminating in a Switchboard located at a desired location, shall be provided by contractor. The earth bar provided on these Switchboards shall be connected to the building earthing system. All cabling / wiring/loop earthing beyond this Switchboard for interconnection with the Elevator controllers / motors/ indicators / push buttons / safety devices etc. shall be provided by the contractor and its cost shall be deemed to be included in the quoted rates.

C1112.3 Cabling

C1112.3.1 Cabling between switchboard and the controller /Elevator motor shall be with XLPE insulated HR PVC sheathed 1100 volt grade copper conductor armored cables conforming to IS 7098 or PVC insulated, PVC sheathed, 1100 volt grade al conductor armoured cables conforming to IS 1554. Cables shall be terminate ding lands fitted with armour clamps the gland body shall be provide with an internal conical sating to receive the armour clamping cone and clamping nuts which shall secure the armour wires. A PVC shroud shall be fitted to cover the gland body and exposed armour wires

C1112.3.2 Trailing cables for the Elevators shall be EPR insulated stranded copper conductor flexible cables conforming to IS 9968

C1112.3.3 Control cabling shall be with multi core stranded copper conductor PVC insulated and sheathed 1100 volt grade cables conforming to IS 8130. Minimum size of the cable shall be 2.5 sq mm.

C1112.3.4 Where cables pass through walls or floor slabs, pieces of GI sleeves shall be provided for cast into the wall / floor and cable shall be drawn therein. Annular space around the cable in the sleeve shall be sealed with fire proof sealant.

C1112.4 Wiring

- C1112.4.1 All wiring shall be carried out with FRLSH PVC insulated 1100 volt grade stranded copper conductor wires conforming to IS 694 drawn in MS rigid / flexible conduiting system and / or MS raceways. Minimum 2.5 sq mm size wires shall be used. Wires shall be cut only at terminations. Intermediate jointing shall not be permitted. Drawing, cutting and terminating of the wires shall comply with the relevant Indian standard specifications and shall be carried out in the most workman like manner as per standard practice. All normal care like cutting the insulation with a pencil edge, taking care not to cut the strands and proper tightening of terminal connector screws to avoid loose connection or breaking of conductors etc. shall be taken.
- C1112.4.2 Heavy gauge black enameled screw type ISI embossed MS conduits with superior quality accessories approved by Employer shall be used in the work. Conduits could either be recessed in floors / walls or fixed on surface with saddles and clamps. Final connections to vibrating the equipment shall be made with metal flexible conduits. Entire work shall be carried out in work man like manner as per standard practice
- C1112.5 Earthing
- C1112.5.1 Metal enclosures of all electrical equipment and devices including frames of motors, controllers, switchgear, conduits and raceways etc. shall be properly earthed so as to form an equi-potential zone. Loop earthing of vibrating equipment shall be done with flexible copper earthing braid or flexible cables. The Elevator motor frame shall be connected to the building earthing system termination at the switchboard by duplicate loop earthing conductors of appropriate size.
- C1112.6 Associated Civil & Structural Items
- C1112.6.1 All civil and structural items of work associated with erection and operation of Elevators shall be provided by the Contractor at his cost including (but not restricted to) the following.
- Hook for lifting Elevator equipment's in the top of shaft.
 - Temporary scaffoldings and safety barricades during Elevator installation in and around Elevator wells
 - Sill angels
 - Bearing plates
 - Buffer supports
 - Chequered plates
 - Fascia plates
 - Ladders in pits(MS)
 - Safety railing on car top
 - Separator /stretcher beams if required.
 - Dowels for terminal buffers in pit floor during casting.
 - Reduction in shaft if required.

- Elevator machine supporting structure.

- C1112.6.2 The Contractor shall ensure erection and fixing of steel work in such a manner that no RCC wall or any other structural member is damaged.
- C1112.7 Safety Aspects & Procedure
- C1112.7.1 Since Elevator installation consists of a number of electrical and mechanical components having linear/ rotary motions, utmost caution should be exercised while working and all safety precautions shall be rigorously followed.
- C1112.7.2 Only authorized persons shall be allowed to work on Elevator installations and officer empowered for such authorization shall keep proper recorded thereof during the test, inspection and maintenance except where necessary.
- C1112.7.3 If during erection any safety or protection devices is inoperative, special care must be taken to avoid accidents on this account.
- C1112.7.4 Supply at main incoming ironclad switch or circuit breaker shall be switched off before examining any part of the equipment. Whether during periodical inspection, or while carrying out any work on the equipment's (including using the winding handle at times of mains failures) unless power is particularly required or particular operation or tests on the Elevators. The breaker located in OFF position.
- C1112.7.5 The landing and car buttons shall be keep out of circuit by switching on the 'Maintenance Switch' located on the top of the Elevator car during maintenance operators. Whenever maintenance switch is not proved emergency stop switch inside car and or attendant control switch should be used.
- C1112.7.6 Before carrying out any repair work it shall be ensured that none of the electro-mechanical door locks are short circuited either from the controller or at the landings
- C1112.7.7 As a general precaution, fascia plate between the door headers and the corresponding upper landing sill on each floor must be provided.

C1113 SITE TESTING OF ELEVATORS

- C1113.1 Leveling Test
- C1113.1.1 Accuracy of the floor leveling shall be tested with the Elevator empty, fully loaded. The Elevator shall be run to each floor while travelling both in upward and downward directions and the actual distance of car floor above/ below landing floor shall be measured. In each case there shall not be any appreciable difference in these measurements for leveling at the floors when the car is empty and when it is fully loaded. The tolerances for leveling shall be as ± 3 mm accuracy.
- C1113.2 Safety Gear Test

- C1113.2.1 Instantaneous safety gear controlled by a governor, should be tested with contract load and a contract speed, governor being operated by hand. Two tests should be made, however, with wedge clamps or flexible clamp safeties, one with contract load in the car and the other with 68 kg (equivalent to one person) in the car. The stopping distance obtained should be compared with specified figures and the guides, car platform, and safety gear should be carefully examined afterwards for signs of permanent distortion.
- C1113.2.2 Counterweight safety gear should be tripped by the counterweight governor and the stopping distance noted. In this case, however the governor tripping speed should exceed that of the car safety governor but by not more than 10 percent.
- C1113.2.3 During the safety gear test, car speed (from the governor or the main sheave) should be determined at the instant or tripping speed with that stated in I.S. The governor jaws and rope should be examined for any undue wear.
- C1113.3 Contract Speed
- C1113.3.1 This should be measured with contract load in the car, with half load with no load, and should not vary from the contract speed by more than 10 percent. The convenient method is by counting the number of revolutions, made by the sheave or drum in a known time. Chalk mark on the sheave or drum and a stop switch will facilitate timing but care must be exercised to ensure that no acceleration or retardation periods are included. If the roping is 2 to 1 the sheave speed is twice the car speed. Alternatively, the speed can be measured by a tachometer applied directly to shaft immediately below the sheave.
- C1113.4 Elevator Balance
- C1113.4.1 After the above test, some of the weight shall be removed until the remaining weights represent the figures specified by the tenderer. With this condition car at half way travel the effort required to move the Elevator car in either direction with the help of winding wheel shall be as nearly as can be judge by the same.
- C1113.5 Car and Landing Doors Interlocks
- C1113.5.1 The Elevator shall not move with any door open. The car door relay contact and the retiring release cam must be tested. The working of the door operation and the safety edges and light equipment if any provided shall also be examined.
- C1113.6 Controllers
- C1113.6.1 The operation of the contactors and interlocks shall be examined and it shall be ascertained whether all requirements laid down in the specifications have been met.
- C1113.7 Normal Terminal Stopping Switches
- C1113.7.1 This shall be tested by letting the car run to each terminal landing in turn, first with no load and then with contract load and by taking measurements, top and bottom over travels can be ascertained.
- C1113.8 Final Terminal Stopping Switches
- C1113.8.1 The normal terminal stopping switches shall be disconnected for this test. It shall be ensured that these switches operate before the buffers are engaged.
- C1113.9 Insulation Resistance

C1113.9.1 This shall be measured (after removing the electronic PCB's and their connection) between power and control lines and earth and shall not be less than 5 mega-ohms when measured with D.C. voltage of 500 volts. The test shall be carried out with contactors so connected together as to ensure that all parts of every circuit are simultaneously tested.

C1113.10 Earthing

C1113.10.1 All conduits, switches, casing and similar metal work shall have earthing continuity.

C1113.11 Ropes

C1113.11.1 The size, number construction and fastenings of the ropes should be carefully examined and recorded.

C1113.12 Buffers

C1113.12.1 The car should be run on to its buffers at contract speed and with contract load in the car to test whether there is any permanent distortion of the car or buffers. The counterweight buffers should be tested similarly.

C1114 TESTS AT MANUFACTURER'S WORKS

C1114.1 High Voltage Test

C1114.1.1 The dielectric or electric apparatus (excluding motors, generators and instruments which are tested in accordance with the appropriate Indian Standards wherever they exist) shall be capable of withstanding a test voltage of ten times the working voltage with a maximum of 2000 Volts when applied.

(i) between the live parts and case of frame with all circuits completed.

(ii) between main terminals or equivalent parts with all circuits open, and

(iii) between the Elevator parts of independent circuits.

C1114.1.2 Note: Owing to the impracticability of applying tests (ii), (iii) mentioned above on controllers and similar apparatus after controller wiring has been completed, these tests may be made at convenient stages of manufacturer.

C1114.2 Method of Applying High Voltage

C1114.2.1 The test shall be made with alternating voltage of any convenient frequency, preferably between 49 to 60 cycles per second. The test voltage shall be approximately sine-wave form and during the application of voltage with peak value, as would be determined by spark gap by oscillography or by any other approved method shall not be more than 1.45 times the rms value. The rms values of the applied voltage shall be measured by means of a volt meter used with a suitably calibrated potential transformer or by means of voltmeter used in connection with a special calibrated voltmeter winding or testing transformer by any other suitable voltmeter connected to the output side of the testing transformer.

C1114.3 Duration of High Voltage Test

C1114.3.1 The test shall be commenced at a voltage of about one third of the test voltage which shall be increased to the full test voltage as rapidly as is consistent with the value being indicated by the measuring instrument. The full test voltage shall be maintained for one minute. At the end of this period, the test voltage shall be rapidly diminished to one third of its full value before switching off.

C1114.3.2 The oil buffers are examined after the above tests have been made to determine if there has been any oil leakage or distortion and to ensure that the buffers return to their normal positions.

C1114.4 Buffer Test

C1114.4.1 A copy of the test report shall be intimated after testing at works and a copy of the same shall be handed over to the Employer during his visit to the Manufacturer's place.

C1114.5 Performance Test

C1114.5.1 This test is meant for passengers Elevators & Freight cum Passenger Elevator and is conducted to watch the performance of Elevator installation in terms of passenger handling capacity and waiting interval as obtained at site vis-a-vis design, data and conducted as below:

- (i) Waiting interval: (T) This can be worked out by taking the average of several round trip times as observed physically and then dividing it by the number of Elevators in that bank.

$$\text{Handling capacity } H = \frac{300 \times Q \times 100}{T \times P}$$

Where

H = Handling capacity as the percentage of the peak population handled during 5 minutes.

P = Total population to be handled during peak morning/evening period. (It is related to the area for which particular bank of Elevators serves).

Q = Average number of passenger carried in a car.

T = Waiting interval.

C1114.6 Service Temperature Test

- C1114.6.1 A continuous run of one hour should be made with number of starts and stops to reproduce as nearly as practical the anticipated duty in service. (The standard duty cycle is for 90 to 180 start per hour). It is very difficult in practice to carry out this test with alternate starts at full load and no load and it is necessary therefore to simulate these cycles. A suitable test for all motors except squirrel cage motors is to run the car up from the bottom landing with contract load and stop at each floor. From the top floor a non-stop run is made to the lowest floor and the upward journey with stop is then repeated. The time intervals between stops and starts at the floors should be uniform and such as to give about 180 starts in one hour. At the end of this run the temperatures of the armatures and fields of the motor and generator are recorded. The temperature rise should, be within prescribed limit.
- C1114.7 Provision for the Disabled and Handicapped
- C1114.7.1 All the Passenger Elevator shall be provided with following features:
- (a) Elevator control buttons at locations and height specified in IS 15330 - 2003
 - (b) Hall call buttons at locations and height specified in IS 15330 - 2003
 - (c) Hand rails shall be provided on the side walls of the Elevator at height & locations specified in IS:15330-2003. An international symbol of access of the disabled shall be permanently and conspicuously displayed at each and every Elevator landing next to the Elevator entrance (to be provided by signage contractor). Braille notations indicating the floor levels shall be incorporated next to each button at the handicap COP and handicap hall call buttons.
 - (d) A digital voice system for announcing the car position, opening/closing of doors, direction of travel and messages shall be provided as per IS:15330 - 2003
 - (e) A laminated safety glass type mirror of full height shall be installed on rear panel at appropriate position as per IS:15330-2003
- NOTE:**
- Finishes such as ceiling, doors, panels etc. to be approved by Employer prior to finalization of contract / Vendor for elevations
- C1114.8 Schedule of Technical Particulars
- C1114.8.1 The technical particulars called for in Annexure-1 should be filled and furnished in the same format. Any deviations from the tender shall be clearly stated in a separate section in the bid.
- C1114.9 Site visits
- C1114.9.1 The contractor shall if required arrange visits to two of his best installations in the country and accompanying the Employer representatives.
- C1114.10 Schedule of Delivery

- C1114.10.1 The complete scope of work as specified to be completed within the time frame. The tenderer shall clearly indicate the time schedule for all activities including, Technical Clarification of drawings & documents, schedule of delivery from the date of opening of L/C or placement of order/LOI, time schedule for dispatch at site and detailed schedule for Erection and commissioning of all the Elevators.
- C1114.11 Warranty and Maintenance
- C1114.11.1 Two-year warranty (including Defect liability period) on any defects related to materials and workmanship is required. If a defect arises within 24 months of installation which is attributable to faulty design, materials and workmanship, the same should be repaired/replaced without any additional charges to customer. Two years' maintenance during defect notification period by the contractor is applicable.
- C1114.11.2 Operation and Maintenance of the Elevators, for a period of two (2) years (including Defect Liability Period) from the Taking-Over of Whole of Works or Section(s) as applicable.
- C1114.12 List of Approved Makes
- C1114.12.1 Mitsubishi Elevator India Pvt. Ltd., ThyssenKrupp Elevator (India) Pvt. Ltd, Kone Elevator India Private Limited, Johnson Lifts Pvt Ltd., Schindler Elevator Corporation, Otis Elevator Company (India) Ltd.

C1115 ANNEXURE 1

C1115.1 Table 1

Technical Specification		
S. No.	Items	Passenger lift Stops G+2
		Requirement by Employer
	Product Name & source	
1	Location of Elevator	Office Building
2	No of Lifts	1 Nos
3	Capacity	Minimum 8 Passenger
4	Speed	1.5 m/s
5	Control/Type of Drive	Variable Voltage Variable Frequency
6	Type of Machine	Gearless Machine
7	Machine room location	MRL
8	Total Travel Height	13.5 m

Technical Specification		
S. No.	Items	Passenger lift Stops G+2
		Requirement by Employer
9	Number of stops/opening	3
10	Elevator Shaft/ Elevator Well Size	2175(W) X 1800(D)mm
11	Car Enclosure /walls	Stainless steel(SS) Hairline Finish
12	Car and landing doors	Stainless steel(SS) Hairline Finish
13	Car Size.	As per Manufacturer
14	Car flooring	Factory Fitted Granite
15	Car Ceiling	Stainless steel(SS) Hairline Finish
16	Door Opening Size and Door Height	900 mm and Height 2000 mm
17	Overhead Required	4600mm
18	Controlling/Operation	Microprocessor based Simlex collective selective control
19	Pit depth	As per Manufacturer
20	Light Fixtures	LED recessed type
21	Ventilation	Blower Fan(Single speed and concealed vents)
22	Fire main switch	Required at GF/Lobby Level
23	Car Emergency Light	Required and 30 min backup required for intercom, Car Ventilation, Emergency light.
24	ARD	Minimum three Rescue device without recharging of battery. ARD Battery Condition:-indicator shall be display in controller.
25	Inter Com	Three-way wiring in contractor scope.(Control room/Controller/Car)
26	Over load Indication	Audio/display
27	Auto Light/Fan (ON/OFF)	Required

Technical Specification		
S. No.	Items	Passenger lift Stops G+2
		Requirement by Employer
28	CCTV with Cabling	Required
29	Fire Requirement 02 Hrs	Required
30	Scaffolding	Included in Elevator Vendors Scope
31	Electricity during Installation	As per Specification
32	Elevator License / permission	All coordination and technical support is included in Contractor's scope
33	Audio Announcement	Required
34	Floor Announcement/Display	Required
35	Protection Against Power Fluctuation	Required
36	Ropes/ Belts	Suspension Traction Media (Belt Technology)
37	Safety Device	Full height facia of S.S required at each floor

C1116 TABLE 2

C1116.1 Common Feature for Elevator

2	Common features for elevators.		
2.1	Display inside car	LED display inside car	
2.2	Voice synthesizer	Optional	
2.3	Is neutral wire available for control circuits	Yes	
2.4	Music (Music Speaker, CCTV)	Trailing cable (Yes)	
2.5	Intercom	Inverter based press & speak intercom shall have common control room at GF/ Basement for all Elevators including wiring conduiting up to control room	

		including EPBAX	
2.6	Load weighing device	Visual as well alarm	
2.7	Fan	Twin blower with linear grill	
2.8	Emergency light& Fan	Yes, inverter base	
2.9	Elevator machine	AC gear less with VVVF main drive & door drive having closed loop operation feature	
2.1	Memory	Elevator should not erase memory in case of power failure & not travel to lower most landing for updating	
2.11	Noise level in car	45dbA	
2.12	Max. Vibration in car	18dbA	
2.13	Self-levelling range	(+)/(-)3mm	
2.14	Power consumption	To be defined by manufacturer as per EN 54/ applicable standards	
2.15	Acceptable voltage variation	(+) 10& (-) 20%	

3	Specific features & Provisions for Differently abled Persons		
3.1	Hand rail	A hand rail of stainless steel hair line finish shall be provided as approved by Employer	
3.2	Car operating panel	Inscription in Braille also to be provided.	
		Level to be lower than the normal so as to be accessible by a person sitting on wheel chair.	
3.3	Hall buttons	Inscription in Braille also to be provided.	
		Level to be lower than the normal so as to be accessible by a person sitting on wheel chair.	
3.4	Car position indicator	The interior of the cage shall be provided with a device that audibly indicate the floor, the cage has reached and indicate that the door of the cage for entrance / exit is	

		either open or close.	
3.5	Hall lantern	To be provided in case more than two Elevator in a lobby	
3.6	Any other feature	As per standard.	
4	Landing signals		
4.1	Hall buttons	Self-illuminating micro-push type in hair line stainless steel facia plates with audio/ visual indication including Digital/LCD Up/down indication, floor no indication etc. complete as required, colour & model as approved by Employer	
4.2	Car Position	Digital position indicators along with direction of travel (with audible signal in each elevator lobby	
4.3	Hall gong	Up/down indicator with single stroke chime at all landing	
4.4	Hall lantern	To be provide as per Employer Requirement	
4.5	Floor Announcement System	(i). Not Required outside of Elevator (In Lobby) (ii). Required inside Car only	
5	Safety features		
5.1	Door safety	Multiple infra-red device to cover the total height and width of the door and with protective leading edge device to operate in case of failure of Infra-red protection	
5.2	Buffer	Spring Buffer to be provided	
5.3	Overload protection	► Overload protective device ► Overload nonstarter.	
5.4	Over travel protection	Terminal and final limit switches to be provided	
5.5	Motor protection	Trip devices for : ► Over current ► Under voltage	

		▶ Over voltage	
		▶ Single phasing	
		▶ Earth leakage	
		▶ Phase reversal	
5.6	Interlocking of car and hoist way doors	To be provided as per specifications.	
5.7	Automatic Rescue Device (ARD)	To be provided	
5.8	Safety from jerk in case of power failure	In case of power failure, car operation shall be smooth without any jerk. suitable arrangement to be made by vendor	
5.9	Belt/ Rope	Only metallic wire rope acceptable with Elevator	
5.10	Dynamic brake	Car not free fall in any case & Elevator shall be with dynamic brake	
5.11	Emergency Alarm Bell	It shall be at Ground floor of the Elevator shaft	
5.12	Ventilation in the Car enclosure	As per Clause 5.4 of BIS code 14665(part- 4/Sec-3) Ventilation opening shall be provided in Elevator car enclosure above-1.8 m Level.	
5.13	ELCB/RCCB	2 pole ELCB /RCCB of suitable rating shall be provided with light & fan circuit.	
5.14		4 Pole ELCB /RCCB of suitable rating shall be provided Elevator machine motor	
5.15	Elevator on Fireman's Mode	if the car on fire man mode Audio & visual signal as per clause 8.3.14.2.3 (b) of IS code:14865 (part2/Sec1):2000 shall be provided	
5.16	Door Deterrent Device	Car enclosure door not to open from inside the Elevator if car is ill-between the floor as per clause-10.9 of IS code :14665 (Part2/Sec1):2000	
5.17	Tasting of over speed	As per BIS Standard	

	governor		
5.18	Elevator Parking Floor	if Elevator not in use all Elevator shall be reached at their landing (parking) floor which will be decided by Employer & in future landing floor changing option to be provided & no extra charge to be entertain to such type modification in all Elevator.	
6	Associated Civil and structural items	All civil and structural Items of work associated with erection and operation of Elevators shall be provided by the Contractor at his cost including (but not restricted to) the following.	
		Temporary Scaffolding and safety barricades for erection in and around Elevator hoist ways	
		Bearing plates	
		Buffer supports	
		Facia plates	
		Ladder in pits	
		Safety rating on top of car	
		Channels, separators, stretchers etc.	
7	Fireman's switch	To be provided at GF/ Lobby level with all Elevator	
8	Fire Elevator	Fire Elevator shall be as per NBC / IS standard	
9	Shaft lighting	Shall be in the scope of electrical Contractor	
10	Free Comprehensive maintenance Period	Two years after completion of work and handing over of the Elevators in satisfactory operating condition.	

C1117 TABLE 3

C1117.1 Special Data to be Furnished by Tenderers

S. No.	Data to be filled in by Tenderers	Passenger Elevators	Freight cum Passenger Elevator
A	Equipment Details		
1	Machine type (Geared/Gearless)		
2	Reduction gear unit ratio		
3	Drive motor data		
i)	kW		
ii)	Starting current(Amp)		
iii)	F.L. Rated current (Amp)		
iv)	Max. no. of starts per hour.		
v)	Insulation class		
4	Hoist/Governor ropes (no. and size)		
5	Max. temperature tolerance during peak summer months		
B	Special features		
	Tenders to confirm Included /Not included in respect of the following	Included/ Not Included	Included/ Not Included
1	Auto fan off switch		
2	Fan inside the Car		
3	Over load warning indicator		
4	Ni-Cd batteries with charging circuit.		
5	Doors safety		

S. No.	Data to be filled in by Tenderers	Passenger Elevators	Freight cum Passenger Elevator
6	Additional weight permitted inside the car for interiors.		
C	Performance parameters		
1	Levelling accuracy		
2	Governor tripping speed.		

C1200 SEWAGE TREATMENT PLANT

C1201 SCOPE OF WORK

C1201.1 The contractor shall complete the STP design & installation work as illustrated in various sections of contract document and to entire satisfaction of the Employer. Any item not specifically mentioned but may be required to complete the installation shall be supplied and installed by STP contractor.

C1201.2 The STP system shall comprise of following:

- (a) Design, Drawing, Installation, Testing & Commissioning of the complete STP
- (b) Pumps & Associated Equipments.
- (c) Electrical control panels including control wiring, cables & cable trays.
- (d) Connections to all mechanical equipments as per requirements.
- (e) Other miscellaneous items.
- (f) Training of staff.
- (g) Approval from Local Approving Authority

C1202 GENERAL CONDITIONS

C1202.1 Licence, Fees & Permits

C1202.1.1 The Contractor shall hold a valid STP Installation License issued by the Competent Authority having jurisdiction over the Project Area. The contractor shall maintain constant liaison with municipal Authorities, pay all fees/security deposits and other expenses involved in obtaining sanctions from Municipal/other Authorities, submission of various applications forms supporting documents, getting the premises inspected and final sanction of STP installation and for obtaining water supply.

C1202.2 By-Laws and Regulations

C1202.2.1 The installation shall conform to the Bye-laws and Regulations of the concerned authority as applicable to the installation. If the tender specifications and drawings are more stringent than required as per the Local Authorities then the tender specifications and drawings shall be followed. In the other case, if the local authorities more stringent specifications than those specified in the tender specifications, then the set by-laws and regulations shall be followed.

C1202.3 Fees, Permit and Tests

C1202.3.1 The contractor shall obtain all sanctions, permits and license required for the STP installation work at his own cost. The consultant shall have full powers regarding the materials or work got tested by independent agency at the STP contractor's expense in order to prove their soundness and adequacy.

C1202.4 Materials

C1202.4.1 All materials, equipments, fittings and fixtures used in STP works shall conform to the Indian Standards. All material shall be new, sound and robust in construction and well finished. Surplus material after completion of work shall be taken back by the contractor and the cost shall be recovered if the advance payment has been made earlier by the Client.

C1202.4.2 Unless otherwise stated in the conditions of contract, samples of all materials, fittings and fixtures to be supplied by the Contractor shall be submitted to the Employer for his approval. The contractor shall not commence the work until the samples are approved, in writing by Employer. The contractor shall ensure that all the materials incorporated in the work are identical in all respects with the approved sample. All samples not destroyed in testing shall be returned to the Contractor after completion of contract. No payment shall be made for samples destroyed in testing.

C1202.5 Drawings

C1202.5.1 The contractor shall check exact location of the all the equipment / routing of the services shown on the drawing and compare the same with actual site conditions.

C1202.5.2 Two sets of detailed shop drawings of all equipment and materials including layouts for STP plant room, STP room, water supply, waste & soil drainage layout, shall be prepared by the contractor on Autocad on the architectural drawings and as per Interior Designer's drawings and site measurements. All measurable items quantities shall be mentioned on each shop drawing being submitted for approval by the contractor. Minimum seven sets of final shop drawings shall be submitted by the contractor along with the soft copy.

C1202.5.3 Technical submittals in two sets of comprising of manufacturer's catalogue sheets, selection curves and technical data shall be submitted for approval. Similarly samples of all materials like C.I./G.I. / L.A. / PVC pipe, valves, pipe support, valves, puddle flanges and other material, etc. shall be submitted in two sets for approval.

C1202.6 Work and Workmanship

C1202.6.1 The work shall be of the highest standard and conform to the technical specifications both as regard its design and workmanship. Modern tools and first class, latest techniques shall be employed for its execution.

C1202.6.2 Any damage done to the building during the execution of work shall be responsibility of the contractor and it shall be made good by him, at his cost, to the entire satisfaction of the Employer.

C1202.6.3 All STP work shall be executed by skilled workers under the direct supervision of whole time, fully qualified Employers and Supervisors. The contractor shall produce requisite evidence regarding the qualifications of his Employers, Supervisors and other workers.

C1202.6.4 The work shall have to be coordinated with the building work and other allied jobs/trades to the entire satisfaction of Employer.

- C1202.7 Shop Drawings
- C1202.7.1 Within the time frame agreed with the Employer, the contractor shall produce shop drawings using latest version of Auto CAD. Shop drawing for STP works shall indicate Plant Room layout with all equipment marked along with their dimensions, service clearance and their sectional views, STP room details, Detailed cable tray layouts with arrangement of supports, etc. The shop drawings shall indicate installation details with sectional views for every equipment.
- C1202.7.2 The shop drawings shall be prepared based on latest architectural layout, in complete coordination with other services. Initially 2 sets of shop drawings shall be submitted along with 1 soft copy for approval of Employer. Upon obtaining approval on 1 set of shop drawings, contractor shall produce 6 sets of shop drawings for final approval and for issue to all concerned.
- C1202.8 Performance Guarantee
- C1202.8.1 The responsibility for the performance of entire STP system as per design intent shall lie with the contractor including for performance of individual equipment installed by him. The Performa for guarantee to be submitted by contractor is included herein below as Appendix- I.
- C1202.9 Technical Data
- C1202.9.1 The bidder shall be required to fill the Technical Data sheets for the equipment/material selected by the contractor.
- C1202.10 Uptime Guarantee
- C1202.10.1 The contractor shall guarantee an uptime of 98% for the entire system installed by him. In case of shortfall in any month during Defects Liability Period (DLP), the DLP shall be extended by a month.
- C1202.11 Training to Employer's Staff
- C1202.11.1 To familiarize Employer's operating and maintenance team with the STP system installed, the contractor shall depute his team of skilled operators and helpers to operate the STP system for a minimum of 2 weeks, 10 hours operation each day.
- C1202.12 Miscellaneous
- C1202.12.1 A site order book will be maintained at site which will be in the custody of the Employer and all instructions given to the contractor will be recorded in the site order book and the same has to be signed by the contractor to comply with the instructions given therein.
- C1202.12.2 The work will not be considered as complete and taken over by the employer till all the components of the work after being completed at site in all respects have been inspected/ tested by the Employer to his entire satisfaction and a completion certificate issued by the Employer to this effect.
- C1202.12.3 At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit 6 hard copies and 1 soft copy (CD) of As-Built layout drawing and one tracing of each drawing to Employer drawn at approved scale indicating the complete STP work as installed.

- C1202.12.4 The contractor will submit within 15 days of the award of work, a detailed schedule of programme of work.
- C1202.12.5 Prices shall remain firm and free from escalation/variation due to rise and fall in the cost of materials and labours or any other price variation whatsoever including during extended period of completion, if any.
- C1202.12.6 Power supply shall be 3 phase, 4 wire, 415/230 volts A.C. and frequency of 50 cycles per second. All consuming devices shall be suitable for voltage and frequency mentioned above.
- C1202.12.7 The drawing and specifications lay down minimum standard of equipment and workmanship Deviations, if any, should be submitted by contractor in writing within one week of issue of drawings. In the absence of any deviations, it will be deemed that the tenderer is fully satisfied with the intent of the specifications and drawings and their compliance with the statutory and fire insurance provisions including local codes. Where the drawings and specifications conflict, the more stringent shall apply.
- C1202.12.8 The entire installation shall be guaranteed against defective materials or workmanship for a period of 24 months from the date of the installation certified by the consultant and taken over by the Employer. During the guarantee period all the defects shall be rectified by the contractor free of cost.
- C1202.12.9 The tenderer must see the site conditions and take all the aforesaid and foregoing factors while quoting the rates, as no extra will be allowed on any ground arising out of or relating to the aforesaid and foregoing.
- C1202.12.10 The contractor will remove all the debris and surplus earth from work site (belonging to his work) free of cost.
- C1202.13 Quiet Operation and Vibration
- C1202.13.1 The entire installation shall be without undue sound or vibration which may be objectionable in the opinion of the Employer. Such condition shall be immediately corrected by the contractor upon being informed at contractor's expenses.
- C1202.14 Operating Instructions
- C1202.14.1 Upon completion of all work and all tests the contractor shall furnish the necessary skilled labour and helpers for operating this entire installation for a period of Seven (7) days. During this period the contractor shall instruct and train the Employer's representative in the operation adjustments and maintenance of all equipments installed.
- C1202.14.2 The contractor shall submit to the Employer a draft copy of comprehensive operating instructions and maintenance schedule for all systems and equipment. This shall be supplemented but for substituted by manufacturers operating and maintenance manuals.

C1202.15 Mechanical Maintenance

C1202.15.1 The contractor shall provide necessary skills and labour to assure the proper operation of the complete installation by the Employer's staff and to provide all required current and preventive maintenance for all equipment and controls under this contract, for the defects liability period of 24 months from the date of acceptance.

C1202.15.2 The contractor shall receive calls for any and all problems experienced in the operation of the equipment under this contract and shall take steps to immediately correct any deficiencies that may exist.

C1202.16 List of Approved Makes

S. No.	Description of Material	Name of Manufacturer
Pipes And Fittings		
1.	Cast Iron Pipes & Fittings Manhole covers and frames	
	a. DI manhole covers, frames and channel grating	NECO
	b. As per IS:1536	Kesoram Calcutta Electro Steel Calcutta Kapilansh Dhatu Udyog Pvt. Limited IISCO
	c. CILA fitting	Kartar Patel As per IS Standard
2.	Drip seal for CI pipe jointing	Vinod Cement Co. (PJS-43)
3.	GI Pipes (IS: 1239 and IS: 3589)	Tata Steel Jindal (Hissar)
4.	GI pipes fittings	Unik Zoloto M Kirti
5.	Flanges	Class 150 Table H E Table
6.	GI / MS threaded sealant	Loctite
7.	CPVC pipes	Flow guard Astral Ashirwad Pipes Pvt. Limited Supreme

S. No.	Description of Material	Name of Manufacturer
8.	UPVC Pipe	Supreme Prince Finolex Astral
9.	SS Pipes	REMI Jindal Approved equivalent ISI marked
10.	Pipe clamps	Camry Chilly Euro Clamps (GMGR) Hi-tech Approved equivalent ISI marked
Valves		
11.	GM / Forged Brass Valves	Zoloto IBP SIM, Italy OR
12.	Butterfly Valve	Audco KSB CRI SKS
13.	Float Valve Gun Metal upto 40mm	Leader Sant
14.	Wafer Type Check Valve	Advance Kirloskar KSB SKS
15.	Solenoid Valve	Avcon Danfoss
16.	Air Release Valve	Zoloto R.B. IBP OR
17.	Two / Three Way Motorized Valve	Rapid Control Watts

S. No.	Description of Material	Name of Manufacturer
Pumps And Equipments		
18.	Water supply pumps	DP Grundfos WILO ITT Kirloskar
19.	Sewage and Storm Water Drainage Sump Pumps	JS KSB WILO ITT DP
20	Sewage transfer pumps	Kirloskar WILO - Mather & Platt ITT DP (Submersible)
21.	Mechanical Seal	Burgmann Hyfab
22.	Couplings	Lovejoy
23.	Anti Vibration Mounting and Flexible Connection	Kanwal Industrial Corporation Dunlop Resistoflex
Water Treatment Plant		
24.	Water Treatment Plant	Thermax Ion Exchange KSP HYDRO Employers
25.	Water Treatment Vessel	Wave Cyber - Aventura Structural - Pentair
26.	Multiport valve	Solo / Praher / Midas
26.	Ultra Violet Water Purifier	Eureka Forbes Alfa Water Purifier Eurostar Sukrut
27.	Dosing Pumps	LMI E-DOSE HANNA PENTAIR

S. No.	Description of Material	Name of Manufacturer
Sewage Treatment Plant		
28.	ULTRA FILTRATION MODULE	Hydranatics - USA Oltremare (ITALY) NORRITT KOCH
29.	Venturi Nozzles	Aqua & Co., Italy
30.	Screw Pump	Rotopump Water supply specialists Kirloskar UT
31.	Air Blower	Kay Everest Beta
32.	Floating air blower	Aqua & Co., Italy
33.	Disc Type Air Diffuser	OTT Anjaneya
34.	Vacuum pump	Usha
35.	Pressure Switch	Danfoss System Sensor Indfos SMC
36.	Centrifuge	United Apollo
37.	Surface Fixed Aerator (STORMIX)	Aqua & Co. (Italy)
38.	Level Switch	Aster Eqvt.
39.	Pressure Gauge	H Guru Fiebig Waree Wika Flotec
40.	Water Meter (Mechanical Type)	Kaycee Capston Kranti
41.	Electronic flow meter	VATS Addmass

S. No.	Description of Material	Name of Manufacturer
		Shenitronics
42.	Level Controller (Water)	Technika Advance Minilec Nevel Co Auto Pumps
43.	Paints	Asian Paints Shalimar Paints Rajdoot MRF Berger J & N
44.	MH / Water Tank Plastic Steps	KGM Approved Equivalent ISI marked
46.	Firestop joint filler	Promat Hilti
47.	Welding Rods	Advani Esab Modi
48.	Fastner	Hilti Fisher Arrow
49.	Chemical holding tank	Sintex Polycon
50.	Flow meter	UKL H ₂ O VATS
51.	PH / DO Meter	Eutech Singapore ASTER

C1202.17 Electrical Accessories

S.No.	Description Of Material	Name Of Manufacturer
1.	Motor Control Centre	Adlec Milestone Tricolite Syspro

S.No.	Description Of Material	Name Of Manufacturer
		Rital App. Equivalent
2.	PLC	Delta Omron
3.	VFD	Delta Danfoss
4.	GPRS	Web compatibility with LAN/ GPRS
5.	Air Circuit Breaker (3/4 Pole)	Schneider Electric (MG) MDS Legrand Hager (L&T) Siemens ABB
6.	Motor	Siemens Bharat Bijlee ABB Kirloskar CG
7.	Soft Starter	Allen Bradley Crompton
8.	Variable Speed Drives	Danfoss ABB Siemens
9.	Starter, Contactor, Push Button	Schneider Electric (MG) Larsen & Toubro (ESBEE) Siemens Vaishno Electricals ABB
10.	Moulded Case Circuit Breaker (MCCB)	Schneider Electric (MG) Asea Brown Boveri Larsen & Toubro (D-Sine) ABB Siemens MDS Legrand
11.	Miniature Circuit Breaker (MCB)	Schneider Electric (Multi-9) Hager (L&T) Siemens

S.No.	Description Of Material	Name Of Manufacturer
		ABB
12.	Overload relays with built in Single Phase Preventer	ABB GE Power Controls Larsen & Toubro Mitsubishi Electrical Schneider Electric Siemens Omron
13.	Current Transformer (Epoxy Cast Resin)	Automatic Electric Indcoil Pragati Gilbert & Maxwell Precise Kappa
14.	Power Capacitor	Meher (Larsen & Toubro) Siemens (Epcos)
15.	Automatic Power Factor Correction Relay (Numeric Type)	Beluk (Germany) Conzerv Larsen & Toubro Alstom
16.	Protection Relay	
	a. Numeric Type	Alstom ABB Siemens Easun Reyrolle
	b. Electromagnetic Type	Alstom Easun Reyrolle
17.	Switch Fuse Unit, HRC Fuse	Larsen & Toubro GE Power Controls Siemens
18.	Rotary Switch	ABB Larsen & Toubro Schneider Electric Siemens
19.	Timer Delay Relay	Larsen & Toubro Siemens Bhartia Cutler Hammer

S.No.	Description Of Material	Name Of Manufacturer
20.	Timer	ABB BCH GE Power Control Larsen & Toubro MDS Legrand Schneider Electric Siemens
21.	Selector Switch, Toggle switch	Salzer (Larsen & Toubro) Kaycee
22.	Change Over Switch	Larsen & Toubro H H Elcon HPL – Socomec
23.	Ammeter and Voltmeter	Rishabh (L& T) Automatic Electric
24.	Electronic Digital Meters (A/V/PF/Hz/KW/KWH)with LED display	Conzerv CG Schlumberger Rishabh
25.	Static Power Meter & Logger (SPML)	Power Measurement Conzerv CG Schlumberger
26.	Indicating Lamps LED type , Push Button	Schneider Electric (MG) Larsen & Toubro (ESBEE) Siemens Vaishno Electricals
27.	PVC / XLPE insulated aluminium/copper conductor armoured MV Cables (1100V grade)	Universal Polycab KEI Batra Henlay, Nicco
28.	PVC insulated copper conductor stranded flexible wires (FRLSH)	R R Kabel Finolex Batra Henlay KEI
29.	Metallic Conduit (ISI approved)	BEC AKG Vimco
30.	Accessories for Metallic Conduit	Sharma Sales Corporation

S.No.	Description Of Material	Name Of Manufacturer
	(ISI approved)	Prakash Engineering Works Super Sales Corporation
31.	PVC Conduit & Accessories (ISI approved)	BEC Precision D Plast Polypack
32.	Cable Tray (Factory Fabricated)	Slottco Profab Employer Needo M M Enterprises

C1202.18 Safety Code

1. Suitable scaffolds shall be provided for workmen for all work that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used, an extra mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than 1/4 to 1 (1/4 horizontal and 1 vertical).
2. Scaffolding or staging more than 3.25 meters above the ground or floor, swung or suspended from an overhead support or erected with stationary support, shall have a guard rail properly attached, bolted, braced and otherwise secured at least 1 meter high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.
3. Working platform, gangways, and stairways shall be so constructed that they do not sag unduly or unequally, and if height of a platform or gangway or stairways is more than 3.25 meters above ground level or floor level, it shall be closely boarded, have adequate width and be suitably fenced, as described in 2 above.
4. Every opening in floor of a building or in a working platform shall be provided with suitable means to prevent fall of persons or materials by providing suitable fencing or railing with a minimum height of 1 meter.

5. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 meters in length. Width between side rails in a rung ladder shall in no case be less than 30 cm. for ladders upto and including 3 meters in length. For longer ladders this width shall be increased at least 6mm.for each additional 30 cm. of length. Uniform step spacing shall not exceed 30 cm.

Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the Sites shall so stacked or placed as to cause danger or inconvenience to any person or the public. The contractor shall provide all necessary fencing and lights to protect public from accidents and shall be bound to bear expenses of defence of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and costs which may be awarded in any such suit, action or proceedings to any such person or which may with the consent of the Contractor be paid to compromise any claim by any such person.

6. **Excavation and Trenching:** All trenches, 1.5 meters or more in depth, shall at all times be supplied with at least one ladder for each 30 meters in length or fraction thereof. Ladder shall be extended from bottom of trench to at least 1 meter above surface of the ground. Sides of a trench which is 1.5 meters or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides collapsing. Excavated material shall not be placed within 1.5 meters of edge of trench or half of depth of trench, whichever is more. Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting be done.
7. All necessary personal safety equipment as considered adequate by the Employer shall be available for use of persons employed on the Site and maintained in a condition suitable for immediate use; and the Contractor shall take adequate steps to ensure proper use of equipment by those concerned.
 - (a) Those engaged in welding works shall be provided with welder's protective eye- shields.
 - (b) Stone workers are employed in sewers and manholes, which are in use, the Contractor shall ensure that manhole covers are opened and manholes are ventilated at least for an hour before workers are allowed to get into them. Manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to public.
 - (c) When workers are employed in sewers and manholes, which are in active use the contractor shall ensure that the following safety measure are adhered to:
 - (i) Entry for workers into the line shall not be allowed except under supervision of the Contractor's Employer.

- (ii) At least 5 to 6 manhole upstream and downstream should be kept open for at least 2 to 3 hours before any man is allowed to enter into the manhole for working inside.
 - (iii) Before entry, presence of Toxic gases should be tested by inserting wet lead acetate paper which changes colour in the presence of such gases and gives indication of their presence.
 - (iv) Presence of Oxygen should be verified by lowering a detector lamp into the manhole. In case, no oxygen is found inside the sewer line workers should be sent only with Oxygen kit.
 - (v) Safety belt with rope should be provided to the workers. While working inside the manholes such rope should be handled by two men standing outside to enable him to be pulled out during emergency.
 - (vi) The area should be barricaded or cordoned off by suitable means to avoid mishaps of any kind proper warning signs should be displayed for the safety of the public whenever cleaning works undertaken during night or day.
8. All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in a safe condition and not scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities shall be provided at or near places of work.
9. These safety provisions shall be brought to the notice of all concerned by display on a notice board at a prominent place at the work spot. Persons responsible for ensuring compliance with the Safety Code shall be named therein by the Contractor.
10. To ensure effective enforcement of the rules and regulations relating to safety precautions, arrangements made by the Contractor shall be open to inspection by the Employer or his representatives and the Inspecting Officers.
- 11. First Aid and Industrial Injuries:**
- i. Contractor shall maintain first aid facilities for his employees and those of his contractors.
 - ii. Contractor shall make outside arrangements for ambulance service and for treatment of industrial injuries. Names of those providing these services shall be furnished to Employer prior to start of constructions and their telephone numbers shall be prominently posted in Contractor's field office.
 - iii. All critical industrial injuries shall be reported promptly to Employer, and a copy of Contractor's report covering each personal injury requiring the attention of a physician shall be furnished to the Employer.
- 12. Contractor's Barricades:**
- i. Contractor shall erect and maintain barricades required in connection with his operation to guard or protect:
 - a. Excavations

- b. Hoisting Areas
 - c. Areas adjudged hazardous by Contractor's or Employer's Inspectors.
 - d. Employer's existing property subject to damage by Contractor's operations.
- ii. Contractor's employees and those of his sub-contractors shall become acquainted with Employer's barricading practice and shall respect the provisions thereof.
13. Notwithstanding the above conditions, the Contractor is not exempted from the operation of any other Act or Rule In force.

C1202.19 List of Codes (Bureau of Indian Standards)

C1202.19.1 Supply, erection, testing and commissioning of all material as per I.S. code as given below:

1.	<u>Pipes and Fittings for external services</u>	
	IS: 1239 (Part 1 & Part 2)	Mild steel, tubes, tubulars and other wrought steel fittings: Part 1 & 2 Mild Steel tubes.
	IS: 1536	Centrifugally cast (spun) iron for water and drainage
	IS: 1538	Cast Iron fittings for water and drainage
	IS: 2643 (Part 1,2 & 3)	Dimensions for pipe threads for fastening purposes: Part 1, 2 & 3
	IS: 3589	Seamless steel pipes for water and sewage
	IS: 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and vent pipes, fittings and accessories.
	IS: 4346	Specifications for washers for use with fittings for water services.
	IS: 4711	Methods for sampling steel pipes, tubes and fittings.
	IS: 6392	Steel pipe flanges
2	<u>Valves</u>	
	IS: 778	Copper gate, globe, ball and check valves for water supply system
	IS: 1703	Copper float valves (horizontal plunger type) for water supply fittings.
	IS: 5312 (Part 1 & 2)	Swing check type reflux (non return) valves: part 1 & 2.

	IS: 5312 (Part 2)	Swing check type reflux (non return) valves: part 2 Multi door pattern.
	IS: 12992 (Part 1)	Safety relief valves, spring loaded:
	IS: 13095	Butterfly valves for water supply system
3.	<u>Pumps & Pressure Vessels</u>	
	IS: 1520	Horizontal centrifugal pumps for water supply
	IS: 5600	Sewage and drainage pumps
	IS: 8034	Submersible pump sets for water supply
4.	<u>General</u>	
	SP: 6 (1)	Structural Steel Sections
	IS: 325	Three Phase Motors
	IS: 694	PVC insulated cables for working voltages upto & including 1100 V.
	IS: 779	Water meters (domestic purpose).
	IS: 800	General construction in steel
	IS: 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
	IS: 1172	Requirements for water supply, drainage and sewage
	IS: 1742	Building drainage system.
	IS: 2379	Colour code for pipe lines.
	IS: 2629	Hot dip galvanizing on iron and Steel.
	IS: 3114	Laying of cast iron pipes
	IS: 4111 (Part 1)	Ancillary structures in sewerage system: Part 1 manholes.
	IS: 6159	Design and fabrication of material, prior to galvanizing.
	IS: 8419 (Part 1)	Requirements for water filtration equipment: Part 1 Filtration medium sand and gravel.
	IS: 8419 (Part 2)	Requirements for water filtration equipment: Part 2 under drainage system.
	IS: 9668	Provision and maintenance of water

		supplies and fire protection.
	IS: 11149	Rubber Gaskets
	BS: 6700	Design, installation, testing and maintenance of services supplying water within buildings and their cartilages.

C1202.20 General

C1202.20.1 Sewage system shall be based on IS: 1742 and latest standards for drainage.

C1202.20.2 Sewage Treatment Plant consisting of preliminary, biological and tertiary treatment for recycling of the effluent. The treated water shall be used for flushing, water bodies makeup, washing, AC & DG cooling tower makeup and for irrigation purpose.

C1202.21 Water Storage for Flushing & Distribution System

C1202.21.1 Recycled Water from STP: Water from tertiary sewage treatment plant shall be used for flushing water supply, irrigation water supply, water bodies makeup and washing purpose through separate tanks and set of pumping system.

C1203 BASIC MATERIALS AND METHODS

C1203.1 General

C1203.1.1 All materials shall be new and of the best quality and shall conform to the latest Indian Standard Specification.

C1203.1.2 All materials shall be of approved quality as per samples and origins approved by the Employer.

C1203.1.3 As and when required by the Employer, the contractor shall arrange to test the materials and/or portions of the works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions of work are found defective or unsound by the Employer, the contractor, shall remove the defective materials from the site, pull down and re-execute the works at his own cost to the satisfaction of the Employer. To prove that the materials used are as specified, the contractor shall furnish to Employer with original vouchers on demand.

C1203.1.4 All works executed shall be as directed and to the satisfaction of the Employer.

C1203.1.5 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

C1203.1.6 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted to short connections.

C1203.1.7 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.

C1203.1.8 Pipes shall be securely fixed to walls and ceilings by suitable G.I. clamps, hangers, channels and I section at intervals as specified.

- C1203.1.9 Clamps, hangers, channels, I section and supports on RCC walls, columns & slabs shall be fixed only by means of approved make of expandable metal fasteners inserted by use of power drills.
- C1203.1.10 All pipes clamps, supports, nuts, bolts, washers shall be galvanized MS steel throughout the building. Painted MS clamps & nuts, bolts & washers shall not be accepted.
- C1203.1.11 Valves and other appurtenances shall be so located so as to provide easy accessibility for operations, maintenance and repairs.
- C1203.2 Design Highlights
- C1203.2.1 The System proposed based on Moving Bed Bio reactor (MBBR) Technology followed By Advanced Ultra Filtration for clear water & is gaining worldwide acceptance as a technology of choice for waste water treatment.
- C1203.2.2 Lesser footprint compared to conventional treatment plant.
- C1203.2.3 Better effluent quality compared to conventional treatment.
- C1203.2.4 Low chemical consumption and simple cleaning.
- C1203.2.5 Using backwash increases net flux and recovery.
- C1203.2.6 Simple and efficient element and module design. Easy servicing of modules and elements because elements are self-supporting.
- C1203.2.7 UF Membranes with PVDF (OUTSIDE IN) with air scouring

C1204 DESIGN CAPACITY

C1204.1 Sewage treatment Plant

Plant Capacity :	5 M ³ /day
Flow rate :	0.25 m ³ /hr
Service cycle :	20 to 22 Hours

C1204.2 Raw Sewage Analysis

C1204.2.1 Raw sewage characteristics for design:

Sl. No.	Parameter	Unit	Average
1.	pH	-	6.5 – 8.5
2.	Suspended Solids	Mg/l	250-300
3.	BOD (5 days at 20 °C)	Mg/l	350 - 400
4.	COD	Mg/l	600 – 800
5.	Oil & Grease	Mg/l	20 – 50

C1204.3 Treated Sewage Analysis

Sl. No.	Parameter	Unit	Treated water
1.	pH	-	6.5–8.5
2.	Suspended solids	Mg/l	< 1
3.	BOD	Mg/l	< 10
4.	COD	Mg/l	< 50
5.	Oil & Grease	Mg/l	< 5

C1204.4 Process Description

C1204.4.1 Moving Bed / Fluidized Media Bio Reactor (Mbbf / Fmbr)

C1204.4.2 Conventional waste water treatment technologies like submerged aerated fixed film (SAFF) reactor, Rotary biological contactors (RBC), Tricking filters or other activated sludge processes have inherent disadvantages of large area of operation, higher power inputs and constant operator attention.

C1204.4.3 In line with latest technologies related to Water & Waste water treatment, We now have a Moving Bed or Fluidized Media Reactor using attached growth process for Waste water treatment, With specially designed floating air diffuser / conventional root blowers which are easy to clean (since its floating) & consume only 40%energy as compare to normal air blower. They are absolutely silent in operation & require almost no regular maintenance like oil changing etc.

C1204.4.4 As compared to conventional technologies, Fluidized media reactors are compact, energy efficient and user friendly.

C1204.4.5 The Fluidized Media Reactor process refers to the operation of activated sludge tanks in various configurations in a combination of

- (a) Suspended biomass
- (b) MLSS (mixed liquor suspended solids)
- (c) Attached biomass,
- (d) Such kind of operation is generally classified as Hybrid Moving Bed Biofilm Reactor (MBBR).

C1204.5 Basic principle

C1204.5.1 Flock forming organism's form clusters or attach to available surfaces. The Fluidized Media Reactor carrier material allows high biomass concentrations per cubic meter of material, which:

- Increases the specific volumetric capacity of activated sludge tanks
- Controls biomass activity
- Reduces operating cost

- C1204.5.2 The single tank aeration design unit, incorporating a bar screen, a specially designed tank with hybrid fluidized media, a lamella plate clarifier / tube settler and tertiary treatment with UV & Ultra Filtration. The bar screen removes larger floating matter and suspended particles. The media significantly increases the surface area for bacterial growth. Air is supplied through surface aerators / root blowers. The bacteria oxidize the organic matter present in the sewage. The oxidized sewage overflows in the lamella settler. Suspended particles in the treated waste water settle, with a part of the settled sludge sliding back to the aeration tank. Treated water overflows into a chemical contact tank for chlorination (disinfection), after which Multigrade pressure filtration followed by activated carbon wherein the treated water is disinfected & color / smell if any is removed.
- C1204.5.3 Treated effluent from Aeration tank overflows to the lamella plate settler, where finer bio-mass and suspended solids are settled. The settled solids slide back into the Aeration tank, thus reducing the need of a re-circulation pump. Excess bio-mass is periodically removed. The sludge can be taken to Sludge drying beds or can be formed into a cake by using a centrifuge.
- C1204.6 Centrifuge / Sludge Dewatering
- C1204.6.1 Centrifugal basket type dewatering system must be incorporated with CI / MS body duly painted with anti corrosive painting. It must also have an SS / MS RL / MS FRP basket with suitable diameter as per the sludge generation volume or handling capacity. The operation of the centrifuge must be intermittent & not continuous duty. The sludge removal system shall be top loading & top discharge with manual scrapping. Suitable scrapping tools must be supplied along with the system itself for proper operations of the system.
- C1204.7 System Automation
- C1204.7.1 Automation of the STP Panel shall be using the following:
- (a) PLC (Programmable Logic Controller) –
 - (1) Capable of upto 256 Digital & Analog Input / Outputs with expansion cards.
 - (2) Program can be saved & backup may be taken directly without connecting a Laptop.
 - (3) Data communication ports available are RS – 232, RS – 485 for high speed data transfer
 - (4) PLC has detachable digital key pad for directly programming without Laptop.
 - (5) PLC keypad may be mounted on the panel visible from outside.
 - (6) BMS Compatibility with use of any additional software like SCADA or existing BMS platforms.
 - (7) Compatible with HMI (Human Machine Interface) – Touch Screen
 - (b) Level Switches for controlling pumps for all the tanks.
 - (c) Touch Screen HMI based panel for controlling all the equipments & having a centralized display for all instrumentations with a USB port for direct data transfer.

- (d) Parallel manual operation facility for the entire panel except automation in case of a PLC-HMI failure or emergency.
- (e) Selector switches for Auto / Manual operations.
- (f) Instrumentations
 - (1) PH (Online or offline)
 - (2) TDS / Conductivity (Online)
 - (3) Turbidity (Offline with min. calibration requirements)
 - (4) DO (Dissolved Oxygen)
 - (5) Water Flow – Treated

C1204.8 Civil Works

C1204.8.1 The following are the tentative list of civil works to be carried out by the Contractor which will vary depending upon the STP vendor requirement. STP contractor will furnish all relevant general arrangement drawings and hydraulic level diagram during detailed Engineering stage.

C1204.8.2 Detailed structural drawing based on site soil condition will be furnished to Employer for approval before construction.

Bar Screen Chamber(Coarse)	
Quantity	One
Size	As per vendor
MOC	RCC
Bar Screen Chamber(Fine)	
Quantity	One
Size	As per vendor
MOC	RCC
OGT / GRT	
Quantity	One
Size	As per vendor
MOC	RCC
Equalization tank	
Quantity	One
Volume in cum	As per Vendor
MOC	RCC
Aeration Tank	
Quantity	One No.
Volume in cum	As per Vendor
MOC	RCC

Treated water storage tanks	
Quantity	Three
Volume in cum	250
MOC	RCC with glazed tiles
Sludge pit	
Quantity	One
Volume in cum	As per Vendor
MOC	RCC with glazed tiles.

C1205 WATER SUPPLY (PIPING AND FITTING MATERIAL)

C1205.1 Piping Schedule

C1205.2 Water Supply System

S. No.	Description	Type of Material
1.	Water tank drains, overflows and warning pipes.	S.S. puddle flanges, UPVC / HDPE pipes
2.	Flushing & soft water supply distribution pipe	CPVC / UPVC heavy class pipe
3.	Irrigation water supply	UPVC, Heavy class pipe
4.	STP equipment piping distribution system	UPVC/HDPE/MS(Air) heavy class pipe

C1205.3 Notes on Pipe work

C1205.3.1 All fittings for pipe work shall conform to the relevant IS Specification.

C1205.3.2 All pipe work shall be free from dust, rust and scale and shall be thoroughly cleaned before erection. Open ends during the progress of work shall be blanked-off with purpose-made of metal caps. Plastic caps or use of wooden plugs is forbidden. Should any stoppage in the circulation occur after the various systems have been put into operation, owing to non-compliance with this requirement, the Contractor shall rectify the matter at no extra cost to the Contract.

C1205.3.3 Pipes shall be installed with correct falls for venting and draining and attention shall be paid to neatness of installation, i.e. groups of pipes shall be accurately spaced and valves, joints, etc., symmetrically arranged. Where two or more pipes are visible and change direction together, bends shall be struck from a common radius point. Adequate clearances shall be maintained in all cases, to allow for the application of the insulation materials and finishing.

- C1205.3.4 The Contractor shall note the restricted space available in certain service ducts, it is absolutely necessary to ensure that all pipe work is installed in the correct sequence, manner and position to ensure that operation of all valves and maintenance is possible.
- C1205.3.5 All reductions in pipe sizes shall be made using approved standard reducing fittings. Reducing bushes shall not be used without approval. Connections between lengths of pipes shall be made using standard fittings. Long threads must not be used.
- C1205.3.6 All pipe work in pump rooms, plant rooms, and on roof level shall be installed with flanges or unions at intervals not exceeding 6m for ease of dismantling.
- C1205.3.7 Changes in direction of pipes shall be made with long radius bends or elbows, as far as practicable. Under no circumstances shall pipes be bent without the use of fittings.
- C1205.3.8 All pipe runs when not installed underground or in duct shall be concealed as far as possible by careful positioning or shall be chased into walls, laid in screed etc, or as directed by the Employer.
- C1205.3.9 All pipe work within the fire protected areas must be enclosed to satisfy the local municipal/fire authority requirements and such enclosures shall be supplied and installed by the Contractor.

C1206 PIPING SPECIFICATIONS

C1206.1 CPVC Pipes & Fittings

- C1206.1.1 The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) for flushing water supply piping system with pipes as per CTs SDR -13.5 at a working pressure of 300 PSI at 23 deg C and 80 PSI at 82°C, using solvent welded CPVC fittings etc. including transition fittings (connection between CPVC & Metal pipes / GI / Cu / or any other materials) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / hanger/ structural metal supports as required as per site condition including cutting chases and making good the same, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings.

C1206.2 Joining Pipes & Fittings

- a. Cutting:
 - Pipes shall be cut with a wheel type plastic pipe cutter or by hacksaw blade.
- b. Deburring / Beveling:
 - Burrs from pipe & fittings shall be removed from the outside and inside.
- c. Fitting preparation:
 - A clean dry cloth should be used to wipe dirt and moisture from the fitting sockets and from tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

- d. Solvent Cement Application:
 - Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings.
- e. Assembly:
 - After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up.
 - Solvent cement set and cure times shall be strictly adhered to as per manufacturer's specifications.
- f. After completing the installation
 - The system should be hydrostatically pressure tested at 150 psi (10 Bar) for one hour.

C1206.3 Threaded Sealants

C1206.3.1 Teflon tape shall be used to make threaded connections leak proof.

C1206.4 Hangers and supports

C1206.4.1 The support should be provided at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (1.2m) intervals for larger sizes.

C1206.4.2 Supports should be as per the below mentioned table:

Size of Pipe	21°C	49°C	71°C	82°C
Inch	Ft.	Ft.	Ft.	Ft.
½"	5.5	4.5	3.0	2.5
¾"	5.5	5.0	3.0	2.5
1"	6.0	5.5	3.5	3.0
1¼"	6.5	6.0	3.5	3.5
1½"	7.0	6.0	3.5	3.5
2"	7.0	6.5	4.0	3.5

C1206.5 UPVC Pipes

C1206.5.1 UPVC Pipes and fittings shall be heavy class manufactured to Indian Standard IS: 4985 (Specification for UPVC pipes & fittings). The Pipes shall be of desired working pressure as specified in the Schedule of Quantities. On delivery to site, the pipes and fittings shall be inspected for thickness, cracks etc. The pipes shall be stored in a sheltered roof as protection against direct sunlight.

C1206.6 Hangers, Channel, I Section, Supports, Anchors and Guides

C1206.6.1 Provide hangers of heavy construction suitable for the size of pipe to be supported. All materials to be of hot dipped galvanized steel (touch up all cut ends with galvanized paint) except rollers which are to be of wrought or malleable iron. Hangers for pipes up to and including 125mm to be adjustable swivel ring, split ring, wrought pipe clamp, or adjustable wrought clevis type.

C1206.6.2 Support vertical piping with double bolt riser clamps attached to the pipe, resting on pre-Engineered spring hanged attached to the floor slab. Use one clamp at every floor. Where pipes are in open shafts, provide forged steel bar brackets fixed to wall.

C1206.6.3 Job or site fabricated products will not be allowed.

C1206.7 Execution

C1206.7.1 Provide hanger rod sizes in accordance with the following schedule:

Pipe Size	Rod Size
25mm and smaller	10mm
32mm to 50mm	10mm
65mm to 80mm	15mm
100mm to 125mm	15mm
150mm	20mm
200mm to 300mm	25mm
350mm to 400mm	25mm
450mm	30mm
500mm	35mm
600mm	40mm

C1206.7.2 Provide hangers in accordance with the following schedule:

Hanger Spacing Schedule		
Piping Material	Pipe Size	Maximum Hanger Spacing
UPVC	50 mm & larger	1350mm

C1206.7.3 Anchor fastener can be used for pipe supporting system.

C1206.7.4 For flat slab construction only, support hangers from concrete inserts. Furnish, locate and set such inserts and make sure that such inserts are in place when the concrete is poured. Construct inserts of malleable iron or pressed steel with space for rods of all sizes. Install all inserts for pipes 80mm and larger in size with a reinforcing rod 15mm in diameter run through a slot in the insert specifically provided for this purpose.

- C1206.7.5 For flat slab construction only, if any pipe is to be hung in a space where no inserts have been provided, drill holes in the slab (subject to the Employer's prior approval) and provide rods and hanger attached to an approved fishplate or install double expansion shields connected by a 50mm x 50mm angle, from which the hanger rod is to be suspended. For pipe size 50mm and under, use single shields but the hanger spacing defined herein before to be reduced to 1.5m. The carrying capacity and size of each shield to be calculated on the basis of the spacing indicated above but the minimum size to be 10mm. Install additional shields of the same size so that the number of hangers are of adequate size to support the loads which they carry. Shields may be used in flat concrete slabs only.
- C1206.7.6 Set all inserts for all pipes in ample time to allow concrete work to be performed on scheduled time.
- C1206.7.7 Supports may be directly attached to steel beams of building construction, where they occur, if approved by Employer. Smaller pipes may be suspended from crosspieces of pipe or steel angles, which in turn, are to be securely fastened to building beams. The intention is to provide supports which, in each case, will be amply strong and rigid for the load, but which will not weaken or unduly stress the building construction.
- C1206.7.8 Provide approved support, floor stands, wall brackets, etc., for all lines running near the floor or near walls, which can be properly supported or suspended by the floors or walls. Pipelines against walls and RCC roof slab may also be hung by hangers by anchor fastener carried from approved wall brackets at a level higher than the pipe.
- C1206.7.9 Do not hang piping from other piping. Support of hangers by means of vertical expansion bolts is not permitted.
- C1206.7.10 Anchor piping as required to localize expansion or to prevent undue strain on piping and branches. Anchors to be entirely separate from hangers. All anchor designs to be submitted flex bellows flanged or screw type for approval and to include piping reactions which respective anchors are capable of supporting. Provide all indicated or required expansion loops.
- C1206.7.11 For larger diameter piping in Plant Room, supporting system shall be provided from floor only.
- C1206.7.12 Hangers used for cold piping will support the pipe without piercing the insulation. Use insulation shields to protect the insulation on cold pipes. Weld insulation protection saddles to insulated hot pipes, or any piping subject to axial movement, at roller supports. Space between pipe and saddle to be filled with insulation.
- C1206.7.13 For piping 100mm and larger, support the elbows of the piping adjacent to the pumps with steel base elbow supports from the inertia base which pump is on to prevent loading heavy weights of piping on pump casing. Where inertia base is not provided, base elbows to be supported on floor with 25mm neoprene pad.
- C1206.7.14 All pipes supports shall be of such design and type to allow for the removal of any pipe section without the necessity of disconnecting other adjacent pipes.

- C1206.7.15 In all plant and pump rooms discharge pipe work from pumps, and all pipe work where vibration could be transmitted to the building structure, shall be supported with brackets having a tough rubber lining in contact between the bracket and the pipe shall have anti-vibration hangers/supports.
- C1206.7.16 Where pipes pass through walls, floors, etc., the Contractor shall provide pipe sleeves of one size larger than the diameter. Sleeves pipes shall be galvanized steel. For pipes, where sleeves are fitted through floors/wall they shall extend to at least 20mm clear stud out from the finished floor level.
- C1206.7.17 The space between pipe sleeves and the pipe or insulation shall be completely backfilled with materials having the same fire resistant rating as the walls and floors by the Contractor. Should multi-services or more than one single pipe be laid through box-out, the space between the individual pipe sleeves shall be sealed off. The space between the pipe sleeves and the service pipes shall be back-filled.

C1207 VALVES

C1207.1 General

- C1207.1.1 The Contractor shall supply and installation of all valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems.
- C1207.1.2 All valves supplied shall be suitable for the working pressure and test pressure of the various water supply systems. Test pressure shall be 150% higher than the working pressure.
- C1207.1.3 All valves other than automatic control valves shall be full line size.
- C1207.1.4 Each valve shall have a purpose made reference number plate or label engraved or stamped indicating the manufacturer's catalogue number, pressure and temperature ratings. Valves shall be arranged so that clockwise rotation of the spindle will close the valve. Demo labels are not acceptable.
- C1207.1.5 All valves shall be furnished with accessory material necessary in the piping whether or not shown on drawings.
- C1207.1.6 All valves shall be packed with an approved packing and threads shall be coated with oil and graphite. Packing should be replaced when found deteriorated on site.
- C1207.1.7 Where possible locate all valves at convenient positions of operation from the floor with valve stems upright.
- C1207.1.8 Valves that are flanged shall have flanges comply with BS 4504 as for pipe work.
- C1207.1.9 All valves shall be with screwed or flanged ends as required by the piping system in which they are installed.
- C1207.1.10 Valves shall be selected for the working pressure required for the project.
- C1207.2 Ball Valves

- C1207.2.1 Valves 65mm dia and below shall be forged brass lever operated ball valves or specified in the schedule of quantities, having working pressure not less than 10 Kg./Cm².
- C1207.2.2 All valves shall be approved by the Employer before they are allowed to be used on work.
- C1207.3 Butterfly Valves
- C1207.3.1 Valves 65 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction. Valves shall be provided with matching flanges with neoprene insertion gasket 3 mm thick
- C1207.3.2 All valves 65 mm dia and above shall be C.I double flanged or wafer type single flanged.
- C1207.3.3 Butterfly valve shall be of first quality conforming to IS: 13095-1991.
- C1207.4 Air Release Valves
- C1207.4.1 Air release valves shall be single acting type air valves with bronze/gunmetal internal parts and plastic float.
- C1207.5 Execution
- C1207.5.1 All valves shall be installed only in the upright vertical or horizontal positions unless specifically otherwise required.
- C1207.5.2 All valves shall be installed in accessible locations to facilitate easy removal for repair or replacement.
- C1207.5.3 All valves shall be Installed with operating clearance for handle and stem.
- C1207.5.4 All isolation valves shall be installed on equipment so that valve and piping do not interfere with equipment removal or maintenance. Install unions or flanges on equipment side of valves.
- C1207.5.5 Provide 25mm drain valves with threaded ends for hose connections at drain points, at main shutoff valves, low points of piping systems, bases of vertical risers, and at equipment.
- C1207.5.6 It is necessary to provide by contractor required manual or automatic vent valves at high points of piping systems to facilitate venting of air and to ensure quiet and smooth operation.
- C1207.5.7 All valves shall be provided with renewable seat rings and bronze spindles for cast iron body valves.
- C1207.5.8 Furnish and install other valves, check valves, cocks, etc., as required for the complete and proper valving of the entire installation.
- C1207.5.9 Install butterfly valves in horizontal piping with stem in the horizontal position so that bottom of disk lifts in the direction of flow.
- C1207.5.10 Install butterfly valves in vertical piping and at pump outlet with stem perpendicular to pump shaft.
- C1207.6 Strainers
- C1207.6.1 Strainers shall be installed in all pump suction.

- C1207.6.2 Strainer under 65mm dia shall be pipeline Y-type strainer. Strainer of 65mm or above shall be of vertical (bucket) type, S.S. strainer cast iron body with flanged connectors or otherwise specified in the schedule of quantities.
- C1207.6.3 Strainer mesh shall be stainless steel 316 with filtering area of at least three times the sectional area of the pipe inlet.
- C1207.7 Flexible Connector
- C1207.7.1 Flexible connectors shall be of synthetic fiber reinforced rubber, twin sphere type for flush water and 316 stainless steel bellow type for type fresh water system.
- C1207.7.2 Pressure rating of the flexible connectors shall be the same as the water supply system pressure unless otherwise noted on drawings
- C1207.7.3 Flexible connectors shall be installed in the locations shown on drawings and at all pump suction and discharges. The materials of the flexible connectors shall be suitable for the substances to be conveyed.
- C1207.8 Testing
- C1207.8.1 All water supply system shall be tested to hydrostatic pressure test of at-least one and half time the maximum working pressure but not less than 10 kg/sq.cm. for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved by the Employer.
- C1207.8.2 Piping installed, subsequent to the above pressure test shall be resettled in the same manner.
- C1207.8.3 System may be tested in sections and such sections shall be entirely resettled on completion.
- C1207.8.4 The contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. In case of improper circulation, the contractor shall rectify the defective connections. Contractor shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.
- C1207.9 Protection Against Corrosion
- C1207.9.1 All embedded piping material and accessories shall be suitably protected against corrosion. All embedded GI pipes and fittings shall be protected by applying pypkoat primer (@ 100 gm/sqm) protection coating by thermo fusion process and overlap shall be maintained by 15mm with 100mm thick fine sand all-round in additions to the protective coating as stated above.

C1208 WATER TREATMENT SYSTEM

- C1208.1 Water Softner
- C1208.2 Scope
- C1208.2.1 The scope is inclusive of supply, installation, testing and commissioning of FRP composite vessel Media Filters with Ball valves, frontals, ejector, media, resin, brine tank assembly etc and related support arrangement for frontals.

C1208.3 Filtering Media & Resin

C1208.3.1 The softener should have support media if required and resin quantity in accordance to the Bill of Quantities. The cut-section / General arrangement drawings of the softener along with media and resin detail shall be subject to approval by the Employer /Consultant.

C1209 WATER STORAGE TANKS

C1209.1 General

C1209.1.1 The following provisions should be made by the STP contractor in the Water Storage Tanks

- (1) Opening with sealed manhole cover of required size as per approved drawing.
- (2) Manhole with double sealed manhole cover.
- (3) Inlets, outlets over flows, drains and insect proof vent cowls as required on approved Drawings.

C1209.1.2 Necessary perforations (including puddle flanges where required) for the inlet and outlet pipes shall be provided. Each storage tank shall be equipped with overflow, warning pipes, and vent pipes, and drain sumps (located directly below the manhole) with watertight hinged cover and locking device.

C1209.2 Level Controllers

C1209.2.1 All level controllers, level sensors, level switches and alarms shall be provided and installed by the contractor.

C1209.2.2 Each probe shall be of the correct length for its particular application and tank location. Electrodes shall be polished stainless steel 20mm outside diameter. Electrode holders shall be weather proof in all respect.

C1209.2.3 The earthing probes shall be connected and wired to the building earth system.

C1209.2.4 Each set of electrodes shall be installed inside a 200mm-diameter PVC pipe acting as a wave barrier.

C1209.2.5 The level switch set shall be operated with a stepped down voltage at 24V maximum. Stepped down transformer shall be provided for each set of control probes and shall be installed inside centralized control cubicles inside pump room.

C1209.2.6 Provide interface unit at the pump control panel for the levels to be monitored by BMS (refer to drawing).

C1210 EXECUTION

C1210.1 Tank Disinfection

C1210.1.1 Disinfect all potable water tanks including concrete water tanks according to the following method:

C1210.1.2 A solution of 200-mg/L available chlorine shall be applied directly to the surfaces of all parts of the storage facility that would be in contact with water when the storage facility is full to the overflow elevation.

C1210.1.3 The chlorine solution may be applied with suitable brushes or spray equipment. The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping, and shall be applied to any separate drain piping such that it will have available chlorine of not less than 10mg/L when filled with water. Overflow piping need not be disinfected.

C1210.1.4 The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30-min. after which potable water shall be admitted, the drain piping shall be purged of the 10-mg/L chlorinated water, and the storage facility shall then be filled to its overflow level. Following this procedure, and subject to satisfactory bacteriological testing and acceptable aesthetic quality, water may be delivered to the distribution system.

C1211 PUMPS AND EQUIPMENTS

C1211.1 Water Supply Pumps

C1211.1.1 Pumps: Vertical multi stage, centrifugal type of 2850 RPM speed.

C1211.1.2 Materials of construction shall be as follows:

1.	Impellers.....	Stainless steel 304/316*
2.	Diffusers.....	Stainless steel 304/316*
3.	Shaft.....	Stainless steel 304/316*
4.	Stage pieces.....	Stainless steel 304/316*
5.	Top plate.....	Stainless steel 304/316*
6.	Pump suction/discharge casing.	Stainless steel 304/316*
7.	Pump seal.....	Mechanical bellow seal
8.	Motor bracket.....	Cast iron, treated with special anti corrosive epoxy paint.
9.	Pump mounting foot.....	Cast iron, treated with special anti corrosive epoxy paint

C1211.2 Submersible Sewage and Drainage Pumps

C1211.2.1 Submersible sewage and drainage pumps shall be installed in sump pits consisting of discharge connection.

C1211.2.2 Materials shall be as follows:

Casing	- High grade grey cast iron / S.S. with internal sea water corrosion resistant coating
Impellers	- Cutter type for sewage pumps or non-clog type for drainage pumps as specified in schedule of quantities, chromium-alloyed cast iron material of abrasion resistant.
Shaft	- Stainless steel.
Seal	- Double mechanical seal.
Bearings	- Ball thrust type, grease lubricated
Maximum	- As shown on the Equipment Schedule/Drawing speed
Bolt & Nut	- Stainless Steel

C1211.2.3 Level switches (high/low levels alarm and indications) shall be supplied and installed in the sump pits for the proper operation of the pumps as indicated on Drawings. The switches shall be of mercury float switch type. The lead-lag selection of pumps shall be changed automatically after each cycle.

C1211.2.4 Attention shall be paid to the internal dimensions of the sump pits and covers when selecting pumps.

C1211.2.5 Motor shall be class F insulation and inside the casing to prevent water ingress.

C1211.2.6 The Contractor shall supply and fix pump discharge pipe work, vents, control and power wiring and associated conduit. Three spare packing shall be provided for each pump.

C1211.2.7 The installations shall be complete with the following accessories:

- Seal monitor in oil chamber for leakage checking.
- Thermal switches to project over heated motor.
- Starter panel
- Cable of sufficient length for connection of the control box to the pump.
- A.C. alarm bells.
- Cable holders.
- Sleeve for cables.

C1211.3 Execution

C1211.3.1 Completely align and level pumps, motors and bases. Where pumps and motor are shipped as a unit, realign them in the field.

C1211.3.2 Grout base plates completely to provide a non-deflecting support.

C1211.3.3 Install and align mechanical seals in accordance with the manufacturer's recommendation.

- C1211.3.4 Pump manufacturer or his represented to set packing, adjust impellers and check alignment prior to start-up.
- C1211.3.5 Pump shall be mounted according to vibration isolation section.
- C1211.3.6 Repair all surface damaged during shipping and installation or prior to client's acceptance of the building.

C1212 ELECTRICAL INSTALLATION

C1212.1 Distribution Boards

C1212.2 General

C1212.2.1 Distribution Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system, neutral grounded at transformer. All Distribution panels shall be CPRI / NABL approved and manufactured by an approved panel builder.

C1212.3 Standards and Codes

C1212.3.1 The following Indian Standard Specifications and Codes of Practice shall apply to the equipment and the work covered by the scope of this contract. In addition the relevant clauses of the Indian Electricity Act 1910 as amended up to date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

C1212.3.2 BIS certified equipment shall be used as a part of the Contract in line with Government regulations. Necessary test certificates in support of the certification shall be submitted prior to supply of the equipment.

C1212.3.3 It is to be noted that updated and current Standards shall be applicable irrespective of those listed below.

Miniature Air Circuit Breakers for AC circuits	IS 8828: 1978
Degrees of Protection provided by enclosures for low voltage switchgear	IS 2147: 1962
Code of Practice for installation and maintenance of switchgear not exceeding 1000 volts	IS 10118: 1982
General requirements for switchgear and control gear for voltages not exceeding 1000 volts	IS 4237: 1982

C1212.4 Miniature Circuit Breakers

C1212.4.1 The MCB's shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system.

C1212.4.2 The MCB's shall have a minimum rupturing capacity of 10 KA.

C1212.4.3 The MCB's shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection. The MCB time current characteristic shall coordinate with PVC cable characteristic.

- C1212.4.4 Type test certificates from independent authorities shall be submitted with the tender.
- C1212.5 Final Distribution Boards
- C1212.5.1 Final distribution boards shall be flush mounting, totally enclosed, dust and vermin proof and shall comprise of miniature circuit breakers, earth leakage circuit breakers, neutral link etc as detailed in the bill of quantities.
- C1212.5.2 The distribution equipment forming a part of the Distribution Boards shall comply to the relevant Standards and Codes of the Bureau of Indian Standards and as per detailed specifications included in this tender document.
- C1212.5.3 The board shall be fabricated from 16 gauge CRCA sheet steel and shall have a hinged lockable spring loaded cover. All cutouts and covers shall be provided with synthetic rubber gaskets. The entire construction shall give a IP 42 degree of protection.
- C1212.5.4 The bus-bar shall be of electrical grade copper having a maximum current density of 1.6 ampere per square mm and PVC insulated throughout the length. The minimum spacing between phases shall be 25 mm and between phase and earth 19 mm
- C1212.5.5 Separate neutral link for each phase shall be provided.
- C1212.5.6 All the internal connections shall be with either solid copper PVC insulated or copper conductor PVC insulated wires of adequate rating.
- C1212.5.7 All the internal connections shall be concealed by providing a hinged protective panel to avoid accidental contact with live points.
- C1212.5.8 All outgoing equipment shall be connected direct to the bus bar on the live side. The equipment shall be mounted on a frame work for easy removal and maintenance.
- C1212.5.9 The sheet steel work shall undergo a rigorous rust proofing process, two coats of filler oxide primer and final powder coated paint finish.
- C1212.5.10 All the circuits shall have an independent neutral insulated wire, one per circuit, and shall be numbered and marked as required by the Project Manager.
- C1212.5.11 A sample of the completed board is to be got approved by the Project Manager before commencement of supply and erection.
- C1212.5.12 Before commissioning, the distribution boards shall be megger tested for insulation and earth continuity.
- C1212.6 Sheet Steel Treatment and Painting
- C1212.6.1 Sheet Steel materials used in the construction of these units should have undergone a rigorous rust proofing process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process. The steel work shall then receive two coats of oxide filler primer before final painting. Castings shall be scrupulously cleaned and fettled before receiving a similar oxide primer coat.

C1212.6.2 All sheet steel shall after metal treatment be given powder coated finish painted with two coats of shade 692 to IS 5 on the outside and white on the inside. Each coat of paint shall be properly stoved and the paint thickness shall not be less than 50 microns.

C1212.7 Name Plates and Labels

C1212.7.1 Suitable engraved white on black name plates and identification labels of metal for all Switch Boards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

C1213 MEDIUM VOLTAGE SWITCHGEAR

C1213.1 Medium Voltage Air Circuit Breakers

C1213.2 Technical Parameters

C1213.2.1 The circuit breaker shall be of the air break type, robust and compact design suitable for indoor mounting and shall comply with the requirement of IS: 13947: 1993. Rupturing capacity shall be as per bill of quantities.

C1213.3 Constructional Features

C1213.3.1 The Circuit Breaker shall be flush front, metal clad, horizontal draw-out pattern, three/four pole as indicated in BOQ and fully interlocked. Each Circuit Breaker shall be housed in a separate compartment enclosed on all sides.

C1213.3.2 The Circuit Breaker cradle shall be designed and constructed to permit smooth withdrawal and insertion. The movement shall be free of jerks, easy to operate and positive.

C1213.3.3 All current carrying parts in the breaker shall be silver plated and suitable arcing contacts shall be provided to protect the main contacts which shall be separate from the main contacts and easily replaceable. In addition, ACB should have arc chute cover. Arc chutes shall be provided for each pole, and these shall be suitable for being lifted out for the inspection of the main and the arcing contacts.

C1213.3.4 Self aligning cluster type isolating contacts shall be provided for the Circuit Breaker, with automatically operated shutters to screen live cluster contacts when the Breaker is withdrawn from the cubicle. Sliding connections including those for the auxiliary contacts and control wiring shall also be of the self aligning type. The fixed portion of the sliding connections shall have easy access for maintenance purposes.

C1213.3.5 The cubicle for housing the Breaker shall be free standing dead front pattern, fabricated from the best quality sheet steel.

C1213.3.6 Breaking Capacity = $I_{cs} = I_{cu} = I_{cw} = 65 \text{ KA}$ for 1 Sec.

C1213.4 Operating Mechanism

C1213.4.1 The Circuit Breaker shall be trip free with independent manual spring operated or motor wound spring operated mechanism as specified and with mechanical ON/OFF indication. The operating mechanism shall be such that the circuit breaker is at all times free to open immediately the trip coil is energized.

- C1213.4.2 The operating handle and mechanical trip push button shall be at the front of and integral with the Circuit Breaker.
- C1213.4.3 The Circuit Breaker shall have the following four distinct and separate positions which shall be indicated on the face of the panel.
- C1213.4.4 "Service" -- Both main and secondary isolating contacts closed
- C1213.4.5 "Test" -- Main isolating contacts open and secondary isolating contacts closed
- C1213.4.6 "Isolated" -- Both main and secondary isolating contacts open
- C1213.4.7 "Maintenance" -- Circuit Breaker fully outside the panel ready for maintenance
- C1213.5 Circuit Breaker Interlocking
 - C1213.5.1 Sequence type strain free interlocks shall be provided to ensure the following:
 - C1213.5.2 It shall not be possible for the Breaker to be withdrawn from the cubicle when in the "ON" position. To achieve this, suitable mechanism shall be provided to lock the Breaker in the tripped position before the Breaker is isolated.
 - C1213.5.3 It shall not be possible for the Breaker to be switched "ON" until it is either in the fully inserted position or, for testing purposes, it is in the fully isolated position.
 - C1213.5.4 It shall not be possible for the Circuit Breaker to be plugged in unless it is in the OFF position.
 - C1213.5.5 A safety latch shall be provided to ensure that the movement of the Breaker, as it is withdrawn, is checked before it is completely out of the cubicle, thus preventing its accidental fall due its weight.
 - C1213.5.6 Mechanical and electrical anti pumping devices shall be incorporated in the ACB's as required.
- C1213.6 Circuit Breaker Auxiliary Contacts
 - C1213.6.1 The Circuit Breaker shall have minimum 6 NO/NC auxiliary contacts rated at 16 amps 415 volts 50 Hz. These contacts shall be approachable from the front. They shall close before the main contacts when the Circuit Breaker is plugged in and vice versa when the Circuit Breaker is Drawn Out of the cubicle.
 - C1213.6.2 All accessories of ACBs like shunt trip coil, undervoltage trip coil, closing coil etc. shall be front mounted and continuous rated. ACB should be provided with "ready to close contact" to facilitate foul free synchronization.
- C1213.7 Protective Devices
 - C1213.7.1 The Circuit Breaker shall have protective devices as specified in the Drawings/Bill of Quantities. These will in general be:
 - C1213.7.2 CT. operated thermal overload releases with magnetic instantaneous short circuit release. The overload releases shall be such that each phase can be individually set depending on the phase unbalanced currents. The releases shall have inverse time current characteristics and the magnetic release shall be time delayed with a minimum setting of 25 ms varying upto 300 ms for discrimination without effecting the breaking current capacity of the ACB.
 - C1213.7.3 Over voltage relay.
 - C1213.7.4 Under/No voltage trip coil or Relay as required.

- C1213.7.5 Over current and earth fault IDMT relays with shunt/series trip coil operation as specified.
- C1213.7.6 The Circuit Breakers shall be suitable to accommodate one or more types of protection as specified.
- C1213.7.7 Zone Selective Interlocking
- C1213.7.8 Air Circuit breaker should have Zone Selective Interlocking to reduce the thermal stress on the system in the event of the short circuit.
- C1213.8 Instrument Transformers
- C1213.8.1 The Circuit Breaker shall have the required Current Transformers as specified for metering and protection mounted outside the Circuit Breaker compartment but within the free standing cubicle. The transformers shall comply with the relevant Indian Standards and the Class of Accuracy required for metering and protection. Separate sets of Current transformers shall be provided.
- C1213.9 Metering
- C1213.9.1 The metering required to be provided for each Circuit Breaker shall be as per the Bill of Quantities. Such metering shall not be provided on the front panel of the Circuit Breaker compartment. A separate compartment shall be provided for the metering and Protective relays as required.
- C1213.9.2 Square pattern flush mounting meters complying with the requirements of the relevant Indian Standards shall only be used.
- C1213.9.3 Selector switches of the three way and OFF pattern complying to the relevant Indian Standards shall be used.
- C1213.10 Indicating Lamps
- C1213.10.1 Neon type indicating lamps shall be provided for indication of phases and Breaker position as required in the Drawings/Bill of Quantities.
- C1213.11 Control Wiring
- C1213.11.1 All wiring for relays and meters shall be of copper conductor PVC insulated and shall be colour coded and labelled with appropriate plastic ferrules for identification. The minimum size of control wires to be used shall be 1.5 sq mm.
- C1213.11.2 All control circuits shall be provided with protective MCB. Instrument testing plugs shall be provided for testing the meters.
- C1213.12 Measurements
- C1213.12.1 Protection Release should have inbuilt LCD display, which shall indicate the true RMS values of the currents for each phase. A LED bar graph shall simultaneously display the load level on the three phases. A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker. ACB should have earth fault current detection capability.
- C1213.13 Earthing
- C1213.13.1 The frame of the Circuit Breaker shall be positively earthed when the Circuit Breaker is racked into the cubicle.

C1213.14 Type Test Certificates

C1213.14.1 The Contractor shall submit type test certificates from a recognized test laboratory for the Circuit Breakers offered.

C1213.15 Coordination Study

C1213.15.1 Manufacturer of Air Circuit Breaker, MCCB, MCB should submit discrimination tables along with SLD to ensure total discrimination between upstream and downstream breakers up to the full breaking capacity of the circuit Breakers.

C1213.16 Moulded Case Circuit Breakers

C1213.16.1 Moulded case circuit breakers (MCCB), incorporated in switchboards wherever required, shall conform to IS 13947: 1993 in all respects. MCCBs shall be suitable either for single phase 240 Volts or 3 Phase 415 Volts AC 50 HZ supply.

C1213.16.2 Total discrimination shall be provided between upstream and downstream breakers. All MCCBs shall have earth fault module (if specifically asked) and front operated. All four pole MCCB shall be suitable for three phase four wire system, with the neutral clearly identified and capable of first make last break feature.

C1213.16.3 Breaking Capacity = $I_{cu} = I_{cs} = 100\%$

C1213.16.4 MCCB cover and case shall be made of high strength heat resisting and flame retardant thermosetting insulating material. Operating handle shall be quick make/break, trip - free type. Operating handle shall have suitable ON, OFF and TRIP indicators. Three phase MCCBs shall have a common handle for simultaneous operation and tripping of all the three phases. Suitable arc extinguishing device shall be provided for each contact. Tripping unit shall be of thermal/magnetic type provided on each pole and connected by a common trip bar such that tripping of any one pole causes three poles to open simultaneously. Thermal/magnetic tripping device shall have IDMT characteristics for sustained over loads and short circuits should be interchangeable. MCCB should be Thermal Magnetic Type upto 250 amps and above 250 Amp. MCCB shall be microprocessor based. The moulded case circuit breaker shall have a rated service short circuit breaking capacity of not less than 35 KA RMS at 415 volts AC.

C1213.16.5 Contact trips shall be made of suitable arc resistant sintered alloy. Terminals shall be of liberal design with adequate clearances.

C1213.16.6 MCCBs shall be provided with following accessories, if specified in drawings/bill of quantities

- UNDER VOLTAGE TRIP
- SHUNT TRIP
- ALARM SWITCH
- AUXILIARY SWITCH

C1213.16.7 MCCBs shall be provided with following interlocking devices for interlocking the door a switch board.

- C1213.16.8 Handle interlock to prevent unnecessary manipulations of the breaker.
- C1213.16.9 Door interlock to prevent door being opened when the breaker is in ON position
- C1213.16.10 De interlocking device (Defeat feature) to open the door even if the breaker is in ON position.
- C1213.16.11 MCCBs shall have rupturing capacity as specified in drawings/bill of quantities.
- C1213.17 Metering, Instrumentation and Protection
- C1213.17.1 Ratings, type and quantity of meters, instruments and protective devices shall be as per drawings and bill of quantities.
- C1213.18 Current Transformers
- C1213.18.1 CTs shall conform to IS 2705 (part -I, II and III) in all respects. All CTs used for medium voltage application shall be rated for 1 KV. CTs shall have rated primary current, rated burden and class of accuracy as specified in bill of quantities/drawings. Rated secondary current shall be 5A unless otherwise stated. Minimum acceptable class for measurement shall be class 0.5 to 1 and for protection class 10. CTs shall be capable of withstanding magnetic and thermal stresses due to short circuit faults. Terminals of CTs shall be paired permanently for easy identification of poles. CTs shall be provided with earthing terminals for earthing chassis, frame work and fixed part of metal casing (if any). Each CT shall be provided with rating plate indicating:
- Name and make
 - Serial number
 - Transformation ratio
 - Rated burden
 - Rated voltage
 - Accuracy class
- C1213.18.2 CTs shall be mounded such that they are easily accessible for inspection, maintenance and replacement. Wiring for CT shall be with copper conductor PVC insulated wires with proper termination works and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.
- C1213.19 Potential Transformer
- C1213.19.1 PTs shall conform to IS 3156 (Part-I, II and III) in all respects.

C1213.20 Measuring Instruments

C1213.20.1 Direct reading electrical instruments shall conform to IS 1248 or in all respects. Accuracy of direct reading shall be 1.0 of voltmeter and 1.5 for ammeters. Other instruments shall have accuracy of 1.5. Meters shall be suitable for continuous operation between -10°C and $+50^{\circ}\text{C}$. Meters shall be flush mounting and shall be enclosed in dust tight housing. The housing shall be of steel or phenolic mould. Design and manufacture of meters shall ensure prevention of fogging of instrument glass. Pointer shall be black in color and shall have Zero position adjustment device operable from outside. Direction of deflection shall be from left to right. Selector switches shall be provided for ammeters and volt meters used in three phase system.

C1213.21 Ammeters

C1213.21.1 Direct operated ammeter with digital display upto 63 amps and CT operated Electronic ammeter with digital display above 63 amps.

C1213.21.2 Ammeters shall normally be suitable for 5 A secondary of current transformers.

C1213.21.3 Ammeters shall be capable of carrying substantial over load current during fault conditions.

C1213.22 Voltmeters

C1213.22.1 Digital voltmeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

C1213.23 Watt meter

C1213.23.1 Watt meter shall be of 3 phase electro dynamic type and shall be provided with a maximum demand indicator.

C1213.24 Power Factor Meters

C1213.24.1 3 phase power factor meters shall be of electro dynamic type with current and potential coils suitable for operation with current and potential transformers provided in the panel. Scale shall be calibrated for 50% lag - 100% - 50% lead readings. Phase angle accuracy shall be ± 40 .

C1213.25 Energy and Reactive Power Meters

C1213.25.1 Trivector meters shall be two element, integrating type, KWH, KVA, KVA hour reactive meters. Meters shall conform to IEC 170 in all respects. Energy meters, KVA, and KVARH meters shall be provided with integrating registers. The registers shall be able to record energy consumption of 500 hours corresponding to maximum current at rated voltage and unity power factor. Meters shall be suitable for operation with current and potential transformers available in the panel.

C1213.26 Relays

C1213.26.1 Protection relays shall be provided with flag type indicators to indicate cause of tripping. Flag indicators shall remain in position till they are reset by hand reset. Relays shall be designed to make or break the normal circuit current with which they are associated. Relay contacts shall be of silver or platinum alloy and shall be designed to withstand repeated operation without damage. Relays shall be of draw out type to facilitate testing and maintenance. Draw out case shall be dust tight. Relays shall be capable of disconnecting faulty section of network without causing interruption to remaining sections. Analysis of setting shall be made considering relay errors, pickup and overshoot errors and shall be submitted to Client's site representative for approval.

C1213.27 Over Current Relays

C1213.27.1 Over current relays shall be induction type with inverse definite minimum time lag characteristics. Relays shall be provided with adjustable current and time settings. Setting for current shall be 50 to 200 % in steps of 25%. The IDMT relay shall have time lag (delay) of 0 to 3 seconds. The time setting multiplier shall be adjustable from 0.1 to unity. Over current relays shall be fitted with suitable tripping device with trip coil being suitable for operation on 5 Amps.

C1213.28 Earth Fault Relay

C1213.28.1 Earth fault relays shall be induction type with inverse definite minimum time lag characteristics. Relays shall be provided with adjustable current and time settings the current setting shall be 10% to 40% in steps of 10%.

C1213.29 Under Voltage Relay

C1213.29.1 Under voltage relays shall be of induction type and shall have inverse limit operation characteristics with pickup voltage range of 50 to 90% of the rated voltage.

C1300 ELECTRICAL DISTRIBUTION SYSTEM

C1301 GENERAL REQUIREMENTS

- C1301.1 The contractor shall design the Electrical distribution system after conducting detailed study on fault level of installations from KSEB upstream point at EHT level to the load end of proposed installation & execute the work as per specification furnished and drawings provided in the Tender document and the best current Engineering practice. Particular attentions should be paid for internal and external access to the electrical equipment in order to facilitate inspection, cleaning and maintenance. Care shall be taken so that the materials and equipment supplied by the contractor will be the standard catalogued products of manufacturers having NABL / CPRI approved makes. The contractor shall comply with latest code of practice published by the Bureau of Indian Standards as listed in the tender document.
- C1301.2 All equipment shall be designed to minimize the risk of fire and any damage, which may be caused in the event of fire.
- C1301.3 All apparatus, equipment and works shall be so designed that they provide satisfactory service and without any harmful effects for prolonged and continuous periods in the worst climatic conditions, stated herein before.
- C1301.4 The equipment rating and SLD provided in the specification are to provide idea about the power distribution system to the contractor. However, the contractor shall carry out detailed load study and accordingly to prepare the SLD and to size the electrical equipment.
- C1301.5 In case the Contractor intends to subcontract the electrical works, the Subcontractor who will be employed shall be a Class A contractor / EHT contractor issued by State Electrical Inspectorate/ Central Electricity Authority. The Contractor shall submit all the required credentials of the subcontractor to the Employer for approval of the appointment of subcontractor

C1302 POWER SYSTEM DESCRIPTION

- C1302.1 Electrical Power Requirement
- C1302.1.1 Electrical distribution system for the “Re-Construction of North Jetty at Naval Base, Kochi” project is designed to feed supply to the vessels, High mast lighting, outdoor lighting, Cranes, Service Gallery, Firefighting system, Water supply system, Power House, Office Cum Store Building including Pump House (G+2), pump house on jetty, DG Room, Compressor House, Guard Room, Watch Towers – 2 Nos. & Entry Gate etc.
- C1302.2 Source of Power Supply
- C1302.2.1 Power will be received from proposed new 110KV MES substation inside naval base, whose location would be nearby foot-over bridge in SMA. The approx. distance from the 110kV MES substation to the project site is 3.75KM. 9MVA installed capacity has been envisaged for new Power House to be constructed on the reclaimed land, for day to day operations of various systems and to meet the peak load demand of about 7500 KVA.

C1302.2.2 Four 11 KV feeders are now proposed to feed installed load capacity of 9 MVA, from the nearly 110 KV MES receiving station, to be connected to new North Jetty Power House, on the 11 KV system. This will include one spare 11KV feeder. These incoming feeders will be connected to 11kV Bus bar in the new north Jetty substation through underground Aluminium cables, where 11 KV switchgear panels will be installed for all incoming & outgoing 11 KV feeders. The contractor shall follow the cable route diagram furnished.

C1302.3 System Arrangement

C1302.3.1 Taking into account the load requirement in each system, following transformers/Frequency converters are proposed to be installed in the substation.

1. 11/0.415KV, 1600 KVA – 6 Nos.
2. 11/0.380 KV, 1600 KVA – 3 Nos.
3. 11/0.440 KV, 1600 KVA – 3 Nos.
4. Static Frequency Converters,440V, 1500kVA, 50Hz to 60Hz – 3 Nos.

C1302.3.2 The L.T output from various Transformer / Frequency convertors will be extended to Pillar boxes, spaced all are on lee side of North jetty and the supply from these pillar boxes will be connected to various cope boxes, fixed in the service gallery on lee side / sea side for giving power to various vessels of different distribution systems i.e. 415V/ 50Hz, 380V/50Hz & 440V/60Hz & 220V DC. In addition to that the LT Panels feed supply to the Building Loads, External and internal lighting & power loads, Crane loads, Service Gallery loads and other utility services.

C1302.4 Utilization Voltages:

C1302.4.1 The particulars of Power Supply shall be as follows:

Voltage	110kV \pm 10%, 11kV \pm 10%, 440V \pm 10%,415V \pm 10%, 380V \pm 10%
Phase	110kV (3 Phase 3 Wires) 11kV (3 Phase 3 Wires) 440V (3 Phase 4 Wires) 415V (3 Phase 4 Wires) 380V (3 Phase 4 Wires)
Frequency	50 Hz \pm 3%, 60 Hz \pm 3%
Combined Voltage & Frequency Variation	10%
Fault Level	31.5kA for 1 Sec at 110kV, 26.3kA for 3 second at 11kV 50kA for 1 second at 415V, 380V & 440V The Contractor shall conduct the fault level study and finalize the level accordingly with the approval of Employer

System Earthing - 415 V	Solidly Earthed
Control Circuits	
Circuit Breaker Protection & Tripping	110 V DC, 2 Wire system

C1302.5 Scope of work & System battery limits

C1302.5.1 Scope of work for the Electrical system is briefly described in the following paragraphs. This has to be read in conjunction with the Single line diagrams for HT & LT system, detailed specification of equipment defined elsewhere in this specification.

C1303 SCOPE OF WORK INCLUDES

C1303.1 General scope of work

C1303.1.1 The contractor shall design the complete Electrical distribution system, Sub systems, equipment, material and services for the North jetty project as per the specification, fault level & drawings.

C1303.1.2 Providing Engineering data, drawing and O&M manuals for Employer's review, approval and records.

C1303.1.3 Supply, testing, packing transportation and insurance the equipment from the manufacturer 's work to the site.

C1303.1.4 Receipt, storage, insurance, preservation and conservation of equipment at the site.

C1303.1.5 Fabrication, pre-assembly (if any), erection, testing and putting into satisfactory operation of all the equipment/ material including statutory clearances & successful commissioning.

C1303.1.6 In addition to the requirements indicated in Technical Specifications, all the requirements as stated in relevant regulations stipulated for successful commissioning of the installation also be considered as a part of this specification and Contractor is bound for compliance the same.

C1303.1.7 The Contractor shall be responsible for providing all material, equipment and services specified or otherwise which are required to fulfil the intent of ensuring operability, maintainability and the reliability of the complete work covered under this specification.

C1303.1.8 The Contractor shall be responsible for the overall management and supervision of works. He shall provide experienced, skilled, knowledgeable and competent personnel for all phases of the project, to provide the Employer with a high quality system.

C1303.1.9 A project execution schedule called Master Network (MNW) in the form of PERT /Gant chart/ network and based on Work break down structure shall be prepared by the Contractor for Employer's approval. The MNW shall identify milestones of key events for each work/component in the areas of Engineering, procurement, manufacture, dispatch, erection and commissioning.

- C1303.2 Detailed scope of work
- C1303.2.1 Design, Fabrication, Supply, Installation Testing & Commissioning of 10/12.5 MVA Outdoor Transformer, 110kV Breaker, Isolator, C.T, CVT/PT, Lightning Arrester, SCADA system etc.
- C1303.2.2 Nitrogen based firefighting system for the Power Transformers with control valves, control cables, piping & accessories etc.
- C1303.2.3 110KV metering bay as per KSEB standard with all measuring and control equipment including surge arrester in the incoming side.
- C1303.2.4 11kV HT, Aluminium cables laying from MES substation to north jetty substation, termination at both ends, testing & commissioning. General condition of the earth is soft marshy. Some portions tarred with rubble soling. However, Contractor shall conduct route survey before submitting their quotes. Concrete cable trench to be constructed all over the route and cable tray to be installed in the trench. Cable shall be laid on the cable tray.
- C1303.2.5 Design, Fabrication, Supply, Installation Testing & Commissioning of 11kV HT Panel Boards, distribution Transformer, Frequency converter, HT/LT cables and control Cables, LT Panel Boards, Distribution Boards, Outdoor distribution boards as shown in SLD.
- C1303.2.6 2 x 250 KVA capacity DG set with auto load management, synchronization and AMF panel to feed power supply to critical load. DG set shall be provided with separate fuel tank suitable for 6-hour operation. A manual fuel filling pump also to be supplied along with DG set.
- C1303.2.7 Design, manufacture, supply and installation of Sandwich type LT bus duct system. However, bus duct is not allowed in the service gallery.
- C1303.2.8 The contractor shall design, supply and install the Battery charger & DC Battery Bank, DCDB etc.
- C1303.2.9 Design, supply and installation of transformer and rectifier unit(300kW) to feed 220V DC supply to the vessel.
- C1303.2.10 Design, supply and installation of capacitor bank with automatic power factor controller (APFC)
- C1303.2.11 Design, supply and installation of UPS in building which will feed power supply to ELV equipment and emergency lighting
- C1303.2.12 Design, supply and installation of Change over switch (COS) panel
- C1303.2.13 Design, supply and installation of 15Ton EOT crane on the substation building including all electrical control system, and bus bar system.
- C1303.2.14 Design, supply and installation of ventilation system for power house building.
- C1303.2.15 The contractor shall design, supply and install the Indoor lighting, High mast lighting and road/jetty lighting system to get desired 'LUX' level as per standard.
- C1303.2.16 Design and installation of point wiring in the buildings including data points/Computer points.
- C1303.2.17 Emergency lighting to be provided in the building which will be fed by UPS. 20% of total building lights shall be of emergency light.

- C1303.2.18 Under deck lighting, service gallery lighting and kerb lighting in the jetty
- C1303.2.19 Supply and installation of aviation lights in the High mast, Elevated water tank, Cranes etc. Separate UPS of 500VA to be provided for feeding supply to the aviation light during power failure.
- C1303.2.20 Providing forced ventilation system (exhaust fan) in the service gallery.
- C1303.2.21 Design, supply and installation of SS-316 grade outdoor Pillar box with rated circuit breakers of marine duty in the jetty
- C1303.2.22 Design, supply and installation of SS-316 grade outdoor cope box in the jetty with proper mounting arrangement. The cope box shall be provided with necessary hardware for easy connection and disconnection of vessel power supply cable.
- C1303.2.23 Supply of Stainless steel Middle Junction Box (Mid JB) and Tension relieving drum (TRD) for 2 number of Jetty cranes.
- C1303.2.24 Cable laying in buried route/trenches/trays as per specification, termination at both ends, testing and commissioning of power and control /instrumentation cables, cables between Switch boards and sub switch boards, between battery charger & DC switch board and various equipment in the building and jetty.
- C1303.2.25 Supply and installation of Straight through jointing kits, End termination kits, Cable glands, lugs etc.
- C1303.2.26 Earthing system includes supply, installation and testing of earth pits and relevant earth conductors as per specification for Switch yard equipment, DG, VCB panel, LT Panels, MCB DBs etc.
- C1303.2.27 Lightning protection system for building, High mast crane etc.
- C1303.2.28 On-grid roof top solar PV system in the administration building and power house building and other buildings suitable for installing the on grid solar panel system with its connected cables and switch gears.
- C1303.2.29 Complete supply & erection of HT/LT panel boards, fixing of cable trays, pipes with all necessary supports including grouting of equipment and related civil works
- C1303.2.30 20% spare to be considered in the panel Boards, cable trays, conduits etc.
- C1303.2.31 Adopter box to be considered in necessary places where the cable quantity is more or difficult to connect in the panel board directly.
- C1303.2.32 The contractor shall supply and install the electrical danger boards, shock treatment charts, etc. on all the panel boards and other places wherever it is required. The contractor shall supply earth discharge rod for switchyard, earth mat of required size and insulation class as per IS for HT/LT panel Boards etc.
- C1303.2.33 The contractor shall supply and install Fire Buckets with stands in switch yard, substation, DG room and jetty area
- C1303.2.34 The contractor shall supply the Single line diagram in laminated sheets in A0 format as desired by the CEA, in Substation, DG room etc.

- C1303.2.35 Contractor shall extend auxiliary LT supply in addition to Main crane supply from substation to crane when crane is at ideal/ not working. Necessary cabling, Junction boxes and all accessories to be provided and installed by the contractor.
- C1303.2.36 The rates quoted for installation should include the charges for painting the conduits & supports as directed by Employer.
- C1303.2.37 Design, supply and laying of earth mat in ground. Mesh size for laying earth mat shall be designed based on the fault level and earth resistance at the proposed location. Soil resistivity shall be measured before designing the earth mat. Design, supply and installation of Crane rail earthing & jetty earthing is in the scope of contractor.
- C1303.2.38 It is the responsibility of the contractor to measure the actual earth resistance value, on award of contract. The Earthing and lightning design is to be carried out by the contractor based on the actual earth resistance value and fault current. The design is to be submitted for Employer approval.
- C1303.2.39 The contractor shall design, supply and install PLC based remote monitoring & control system/SCADA system in the power house for monitoring and control the power distribution system. All the measuring instruments shall be provided with RS485 communication port to interface with the central control system.
- C1303.2.40 The contractor shall design & install exhaust fan system for the service gallery.
- C1303.2.41 Providing anti-static painting on the flooring at power house
- C1303.2.42 Foundation design and related civil work for Electrical equipment, street lights, High mast, panel Boards etc. will be on contractor scope.
- C1303.2.43 Liaison with all statutory authorities for getting sanction/approval/Electrical scheme approval/safety certificate/power connection including submission of necessary forms to KSEB/ Electrical inspectorate/ CEA/ any statutory body as required is included in the scope of this work. Necessary fee for the same shall be in the scope of contractor.
- C1303.2.44 Closing of cable opening/cut-out in the panel boards, cable opening/cut-out in the wall, opening in the used and unused conduit shall be in the scope of contractor.
- C1303.2.45 The contractor shall coordinate with other contractor/ any other agencies for exchange of Data/drawings etc. for making the project success.
- C1303.2.46 PTCC clearance (if any) from the Telecom Department and Road cutting permission from the Kochi Municipality/Panchayat/Navy/other agency shall be responsibility of the contractor.
- C1303.2.47 All the E&M systems shall be designed in accordance to achieve the Green Building rating. All documents required by Client related to Electrical and HVAC shall be submitted for onward submission to Green Building council.
- C1303.2.48 The application form shall be filled by contractor on behalf of Client as advised by Employer.
- C1303.2.49 Onsite training for customer operating staff for routine operation and maintenance procedures.

- C1303.2.50 Supply of commissioning spares & providing list of recommended spares
- C1303.2.51 Items which are not specifically mentioned in the scope of work but shown in the SLD, elsewhere in the specification and drawing also to be supplied and installed to make the system complete.
- C1303.2.52 The SLD furnished in the tender document is only indicative and not cover all the loads. The contractor shall prepare detailed SLD for the power distribution system by incorporating all the services loads, lighting loads etc. and submit the same for Employer approval.
- C1303.2.53 All items within the system boundary limits specified under the scope of this tender shall be included. The contractor scope commences at MES substation and end in the north jetty which cover the complete Electrical work from MES substation to North jetty substation as defined in the scope of work, specification, drawing etc.

C1303.3 Standards and regulations

- C1303.3.1 The design and manufacture of the electrical equipment shall conform as a minimum to applicable codes, regulations and standards published by the following bodies: The design life of the Electrical equipment's are 30 years.

- BIS: Bureau of Indian Standards
- BSI: British Standard Institution
- ISO: International Organization for Standardization
- IEC: International Electro-Technical Commission
- IEEE: Institute of Electrical & Electronics Engineers
- NFPA: National Fire Protection Association
- NEC: National Electrical Code
- ECBC: Energy Conservation Building Code
- CEA: Central Electricity Authority Regulations applicable for safety, construction, metering etc. with its latest amendments

- C1303.3.2 Following is the list of some of the directly applicable Standards particular to the equipment. Any other relevant Indian Standard not covered shall also be applicable.

IS: 375	Marking and arrangement of Switchgear Bus
IS:13118	Specification for high voltage alternating current circuit breaker
IS: 12729	Switchgear and Control gear for voltages exceeding 1000V - General Requirements
IS: 2705	Current transformers
IS: 3156	Voltage Transformers

IS: 335	New Insulating oils
IS: 2026	Power transformers
IS: 3639	Fittings and accessories for Power transformers
IS: 4257	Dimensions of clamping arrangement for porcelain transformer bushings
IS:11171	Specification for Dry-Type Power transformer
IS: 10028	Code of Practice for selection, installation and maintenance of transformer
IS: 3427	A.C. Metal enclosed switchgear and control gear for rated voltages above 1kV and up to and including 52kV
IS:8623	Specification for low voltage switchgear and control gear assemblies of switchgear & control gear for voltages not exceeding 1000V AC.
IS: 13703	Low Voltage fuses
IS: 13947	Low Voltage switchgear and control gear
IS: 1651	Stationary cells and batteries, Lead Acid Type (with tubular positive plates) – Specification
IS: 266	Specification for Sulphuric acid
IS: 3895	Mono crystalline Semi-conductor rectifier cells and stacks
IS: 4540	Mono –crystalline Semi-conductor rectifier assemblies and equipment
IEEE:484	Recommended Design for Installation design and installation of large lead storage batteries for generating stations and substations.
IEEE:485	Sizing large lead storage batteries for generating stations and substations.
IS: 1554	PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.
IS: 7098 -I	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100 volts.
IS: 7098 -II	Cross linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV up to and including 33 kV.
IS: 10810	Methods of tests for cables.
IS: 418	Tungsten filament general service electric lamps
IS: 1777	Industrial luminaire with metal reflectors.
IS: 1947	Flood Lights
IS: 10322	Luminaires for street lighting.
IS: 1944	Code of practice for design of Street lighting

IS: 2206	Flame proof electric lighting fittings
IS: 2215	Starters for fluorescent lamps.
IS: 2418	Tubular fluorescent lamps for general lighting services
IS: 4013	Dust-light electric lighting fittings
IS: 8224	Specification for Electric Lighting fittings for Division 2 areas
IS: 9583	Emergency lighting units
IS: 2713	Specification for Tubular Steel Poles for Overhead Power Lines
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 kV rating.
IS: 732	Electrical wiring installation (system voltage not exceeding 1100 V).
IS: 2309	Code of practice for the protection of building and allied structures against lightning.
IS: 3043	Code of practice for earthing.
IS:15885 (Part2/Sec13)	2012 Safety of Lamp Control Gear, Part 2 Particular Requirements Section 13 D.C or A.C, Supplied Electronic Control gear for LED Modules
IS:16101: 2012	General Lighting - LEDs and LED modules – Terms and Definitions
IS:16102 (Part 1) : 2012	Self- Ballasted LED Lamps for General Lighting Services Part 1 Safety Requirements
IS:16102 (Part 2) : 2012	Self- Ballasted LED Lamps for General Lighting Services Part 2 Performance Requirements
IS:16103 (Part 1) : 2012	Led Modules for General Lighting Part 1 Safety Requirements
IS:16103 (Part 2) : 2012	Led Modules for General Lighting Part 2 Performance Requirements
IS:16104: 2012	D.C. or A.C. Supplied Electronic Control Gear for LED Modules - Performance Requirements
IS:16105: 2012	Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources
IS:16106: 2012	Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products
IS:16107(Part1): 2012	Luminaires Performance Part 1 General Requirements
IS:16107-1: 2012	Luminaires Performance Part 2 Particular

	Requirements Section 1 LED Luminaire
IS:16108: 2012	Photo biological Safety of Lamps and Lamp Systems
IS:60470-2000	High-Voltage Alternating Current Contactors
IS 14286 /IEC 61215	Crystalline silicon terrestrial photovoltaic modules- Design qualification and type approval.
IS/IEC: 61730 –part I	Photovoltaic module safety qualification Requirement for construction
IS/ IEC: 61730 –part II	Photovoltaic module safety qualification- Requirement for testing
IS/IEC 61701	Salt mist corrosion test of the module
IS 16221(Part1)	Safety of Power Converters for use in Photovoltaic Power Systems Part 1-General Requirements
IS 16221(Part2)	Safety of Power Converters for use in Photovoltaic Power systems.
IS 16170 : Part 1 /IEC 61853-Part 1	Photovoltaic (PV) module performance testing and energy rating
IEC 62804	Photovoltaic (PV) Modules Test methods for the detection of potential induced degradation. IEC TS 62804-1 : Part 1 : Crystalline silicon
IEC62716	Photovoltaic PV modules: Ammonia(NH3) corrosion testing

C1303.3.3 In addition to Codes and standards, the installation works shall also conform to the requirements of following:

- Indian Electricity Act
- Fire insurance regulations
- Regulations laid down by Chief Electrical Inspector of Kerala
- Regulations laid down by the Factory Inspector
- Regulations for the electrical equipment of Tariff Advisory committee
- Any other regulations laid down by the authority
- Regulation of Pollution Control Board of Kerala
- Power and Telecommunication Co-ordination Committee (PTCC)
- Kerala State Electricity supply code
- Local Municipal/Panchayat Authority guidelines
- Guidelines for Conservation and Preservation, KSTD

C1303.4 Standardization

C1303.4.1 Care shall be taken so that the materials and equipment are standard catalogued products of manufacturers regularly engaged in manufacturing of such products and shall be of the latest standard designs conforming to specification requirements. Design shall also be based on similar types of electrical equipment supplied from one manufacturer, utilizing interchangeable parts wherever practicable. Materials and equipment incorporated shall be of a type for which spare parts and replacements are readily available in India. The contractor has to always select the Energy Efficient equipment such as Transformers, Pumps, Lights, Refrigerator, etc. in the whole of the project.

C1303.5 Supply of Materials

C1303.5.1 All materials required to complete the work as per given specifications & drawings etc, must be manufactured and supplied using fresh raw materials. Re- moulded, re-circulated materials are not acceptable. The procurement of materials must be made directly from manufacturer or through authorized dealer / distributors. Documentary evidences to this effect are to be made available to the Employer for necessary checks / verification of source of supply of materials. Second hand materials / partial used materials / used materials would not be acceptable. The offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidences during pre-bid meeting. Such deviations suggested may or may not be accepted by the employer. Any deviations projected after the pre bid meeting shall not be entertained at any cost.

C1303.6 Electrical Room & DG Room layout

C1303.6.1 The Electrical substation room shall consist of HT Panel Boards, Distribution Transformers, 440V/415V/380V Main Switch Boards, LT Switch Boards, Frequency converter, Rectifier with transformer, UPS & Battery, etc. DG will be kept in the DG Room. Electrical room/DG room size shown in the layout drawing is only for tender purpose. The contractor has to access all the equipment/room sizes and any changes is necessary, the same to be brought to the notice of the Employer for approval. Necessary clearances to be maintained for all equipment as per statutory requirements.

- C1303.7 Statutory Approvals
- C1303.7.1 The installation shall be in accordance with the CEA regulation and Indian standard as updated time to time and various national and international standards furnished above. The contractor shall arrange to obtain all necessary approvals for the electrical installation as required by the prevalent laws of the state of Kerala. The layout plans including the Earthing and Lightning Protection schemes, etc. shall be approved by the CEA/Regional Electrical Inspectorate Office/any other statutory body prior to taking up the work. Approval for the installation as a whole from the CEA/Regional Electrical Inspectorate Office/any other statutory body after the installation is complete shall also be the responsibility of the Contractor. Necessary application forms as required to be filled up and submitted to the CEA/Regional Inspectorate Office/any other statutory body shall be procured, filled and submitted for approval and the required approval obtained by the electrical contractor prior to asking for the HV/LV line to be energized. Specialized “A” grade licensed Electrical contractor to be appointed by the main contractor for liaisoning and for getting statutory safety approval from the inspectorate.
- C1303.7.2 All expenses towards the overall approval of the installation including the statutory fees will be borne by the contractor. The statutory fee shall be reimbursed by Client on production of actual bill.
- C1303.7.3 Pollution control Board approval (Consent to Establish & operate) also to be obtained by the contractor for DG set. The statutory fees to be paid by the contractor.
- C1303.8 Employer Approval
- C1303.8.1 The contractor is required to submit the total scheme for electrical distribution system in three sets for approval by the Employer after award of contract, prior to commencement of work. These shall include all the Single line diagrams, design calculations, Vendor drawings for Switch boards and other Electrical Equipment’s, detailed drawings for earthing, lighting and lightning protection, cabling, methodology of cable laying, cable schedules, Equipment Erection methodology etc.
- C1303.9 Submittal of data for approval
- C1303.9.1 The contractor shall submit to the Employer complete information regarding details of materials and equipment involved, prior to any purchase or manufacturing operation. Any purchase or manufacturing operations carried out prior to obtaining such approval shall be at the contractor’s sole responsibility.
- C1303.9.2 Information of equipment shall be separately submitted by listing all the details and with attached catalogue indicating at least the model, series, size and performance. Such data shall be in sufficient detail to enable the employer to identify the particular product and to form an opinion to its conformity to the specification.
- C1303.9.3 The contractor shall stamp the name of his company and sign all documents to be submitted for approval.
- C1303.10 Approval of materials

- C1303.10.1 Only new materials and equipment shall be incorporated in the works. All materials and equipment furnished by the contractor shall be subject to inspections and approval of the employer. The materials and equipment used for works shall be of approved makes. Any materials which, in the opinion of the employer, have lower quality than the approved makes shall promptly be removed from the job site.
- C1303.10.2 Whenever requested by the employer, the contractor shall send materials to be tested by an independent institute selected by the employer.
- C1303.10.3 Submittals of Materials: Manufacturer drawings, catalogues, pamphlets and other documents submitted for approval shall be in three sets. Each item in each set shall be labelled properly, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted. The format of submittals shall be approved by employer's representative.
- C1303.11 Shop drawings
- C1303.11.1 As soon as the contract is awarded, the contractor shall prepare shop-drawings comprising complete details of items to be fabricated and works to be installed. These shop-drawings shall be submitted to the employer for approval.
- C1303.11.2 The drawings shall be checked by the contractor for accuracy with regard to dimensions taken in the building(s) and shall closely follow manufacturer's recommendations. All submitted drawings shall be signed by the contractor and shall indicate the date of submission and the date(s) of revision(s).
- C1303.11.3 In case shop-drawings require modifications for any reason, the contractor shall clearly identify the portion that was modified and shall indicate the running number of revisions every time that a revised shop drawing is submitted.
- C1303.11.4 The installation details shall be checked with the building works, the structure and other related trades to prevent conflicts that may cause delay of the project.
- C1303.11.5 Size and scale of the shop-drawings shall be at least 1:100 scale except for enlarged scale details done for clarity, which shall be in conformity with international standards or as directed by the employer.
- C1303.11.6 Where required by the employer, the contractor shall prepare additional drawings, diagrams, etc., which in opinion of the employer are considered necessary for a proper execution of the works.
- C1303.11.7 The contractor shall not proceed with his work for a certain part or section, prior to the approval of the shop-drawings. Therefore, expense incurred because of modifications that have to be made as a result of lack of approved shop-drawings shall be borne by the contractor.
- C1303.11.8 Approval of the shop-drawings by the employer shall not be construed as a complete check but will indicate only the general method of installation and its details are satisfactory.
- C1303.11.9 The approval of the employer shall not release the contractor from his responsibility or his liability regarding the exact dimensions and further properties of the installations.

- C1303.11.10 Shop-drawings submitted without sufficient detail shall be rejected and new submittal shall be required.
- C1303.11.11 The contractor shall submit 3 blueprint copies of all shop-drawings for approval. If approved by the employer, one copy shall bear the employer's stamp indicating the date of approval and shall be returned to the contractor. After approval, 6 copies and a softcopy of blueprint are required, and additional copies may be requested by the employer as necessary.
- C1303.11.12 The Employer shall issue the approval for the documents / drawings submitted by the contractor based on the recommendations of TPIA engaged by the Employer.
- C1303.12 Field testing
- C1303.12.1 Test all equipment upon completion of installation to ensure that the equipment operates satisfactorily and to conform to contract documents.
- C1303.12.2 Field testing shall be required for all equipment furnished, installed or connected by the contractor to ensure proper installation, setting, connection, and functioning in accordance with the plans, specifications and manufacturer's recommendations.
- C1303.12.3 Testing shall be conducted in the presence of the employer and, when necessary, under the supervision of equipment manufacturers field employer.
- C1303.12.4 All tests recommended by the equipment manufacturer whether specified in this specification or not, shall be included, unless specifically waived by the employer.
- C1303.12.5 Testing shall include any additional tests required by the employer to determine the conditions of that equipment, material and system to meet requirements of the specifications.
- C1303.12.6 The contractor shall maintain in triplicate, a written record of all tests showing date, personnel making test, equipment or material tested, tests performed and results. Three copies of test records shall be given to the employer within the following day.
- C1303.12.7 The contractor shall notify the employer two weeks prior to commencement of any testing, except for metering.
- C1303.12.8 Contractor shall be responsible for any damage to equipment or material due to improper test procedures or handling test apparatus, and shall replace or restore any damaged equipment or material to original condition.
- C1303.12.9 Safety devices such as rubber gloves and blankets, protective screens and barriers, danger signs, etc. Shall be provided by the contractor and shall be used to protect and warn adequately all personnel in the vicinity of the tests.
- C1303.12.10 The contractor shall furnish all testing equipment and provide proper temporary power source for testing purposes when normal supply is not available at the time of testing.

- C1303.12.11 Submission of Material Quality Plan (MQP) & Field Quality Plan (FQP): The Contractor shall submit MQP and FQP of all materials and works to the Employer before commencement of procurements action / engaging work force for erection of equipment.
- C1303.13 Operation and maintenance instructions manual
- C1303.13.1 The manual shall be prepared in hard cover binding in sets to be submitted to the employer on acceptance of the completed work.
- C1303.13.2 Section 1 – comprises submittal data of all equipment and materials that have been approved.
- C1303.13.3 Section 2 – comprises catalogues, categorized in groups, complete with installation operations and the maintenance manuals from the manufacturers.
- C1303.13.4 Section 3 – comprises filled out field test reports.
- C1303.13.5 Section 4 – comprises spare parts list and recommended spare parts.
- C1303.13.6 Section 5 – comprises maintenance and services schedule, and service and maintenance procedures for individual equipment listed daily, weekly, monthly, quarterly and yearly.
- C1303.13.7 Section 6 – comprises system operations manual
- C1303.13.8 A draft copy of the manual shall be submitted to the employer for approval first.
- C1303.14 Works to completion
- C1303.14.1 The contractor shall commission, clean down, and leave in full working order the works as specified.
- C1303.14.2 As the installation proceeds the contractor shall prepare 'As built drawings'. It shall be sufficient to modify these contract drawings showing any revisions which have been made and submit the marked-up prints to the employer for approval.
- C1303.14.3 The contractor shall deliver to the employer on completion of the works, manufacturer's literature, specifications, technical information and 'As built drawings' for all equipment installed.
- C1303.15 Quality assurance
- C1303.15.1 The contractor shall operate his own quality assurance system BS EN 9001 or equivalent acceptable to Employer. The contractor shall prepare a Quality assurance plan and submit for approval of the Employer before carrying out Construction, installation, inspection and testing of items. This quality assurance plan shall be submitted to the Employer within two weeks of issue of order to commence the works.
- C1303.15.2 On award of contract, the contractor shall submit (with in two week) the detailed Design, Procurement, Manufacturing and Delivery and Installation Plan for complete E&M systems.
- C1303.16 Drawing and Documentation required along with Bid
- C1303.16.1 The Bidder shall submit in his Technical Bid the drawings, diagrams and all such information which are necessary to fully understand the offer both technically and commercially.

C1303.16.2 As a minimum requirement the following information shall be supplied with the technical bid in sufficient detail to fully describe the scope of work and the services offered:

- Duly filled-in data sheets and the schedules.
- Terminal point details.
- Time schedule for the design, manufacture, delivery, erection, testing, commissioning and trial operation indicating important milestone activities.
- Dimensioned General Arrangement Drawings of each equipment.
- Bill of quantities all items
- Switchyard and substation layout with plan & sections.
- Quality Assurance Plan.
- Catalogues of all equipment.
- List of sub-suppliers.
- Design calculations
- Typical drawings for switchyard equipment, structures and substation equipment.

C1303.17 Drawing and Documentation required after award of contract

C1303.17.1 The drawings and documents to be furnished by the supplier after the award of the contract shall include but not limited to the following.

- Detailed time schedule in the form of network or bar chart for the design, manufacture, delivery, erection, testing and commissioning period with critical milestone activities and other important intermediate dates for uninterrupted progress of the project.
- Duly filled-in revised technical data sheets.
- Quality Assurance Plan.
- List of manufacturers and specifications of all standard equipment.
- Dimensioned General Arrangement Drawings, wiring diagrams, name plate details, terminal details, cable box / bushing details and drawings, for all equipment.
- Detailed single line diagrams & schematic drawings.
- Switchyard and substation layout with plan & sections.
- Type and routine test certificates of all items.
- Any other drawings/documents, as required by CEA/statutory body, for getting approval of complete 11 kV & 110 kV systems.
- Catalogues of all equipment.

- Design calculations for the following: Load list, Maximum demand calculation, DG and other equipment sizing calculation, fault level calculation, CT&PT burden calculation, Relay setting calculations & co-ordination charts, Earthing calculations, Lighting calculation, Bus bar sizing calculation, cable sizing calculation, Bus support insulator cantilever strength calculation, lightning protection calculations for switch yard and other buildings
- Construction drawings as listed below: Equipment supports / load data, Switchyard foundation arrangements, switch yard structural drawings, Transformer foundation arrangement drawings, Cable trench & tray drawings, Oil soak pit drawings, Oil drain arrangement drawings, Details of equipment earthing, Final approved cable routing diagram, Cable schedules, Cable interconnection diagram, Approved lighting layout drawing with circuit numbers, Test certificates & inspection reports of all equipment, Other drawings & documents as indicated in various sections of this document, Erection manuals & installation procedures for all equipment, Operation & maintenance manuals for all equipment & systems

C1303.18 Equipment Warranty

C1303.18.1 All equipment supplied under this technical specification shall be required to be guaranteed against defective and/or faulty materials/ workmanship or faulty design. Contractor shall maintain all the systems in a comprehensive manner including all kinds of spares, consumables and tools without extra charge during DLP. Preventative maintenance for all system during DLP shall be under the scope of contractor. Tools and consumables except diesel or oil shall be borne by the contractor.

C1303.19 Abbreviations

ACB	Air Circuit Breaker
AC	Alternating Current
AIS	Air Insulated Switchgear
AMF	Auto Mains Failure
APFC	Automatic Power Factor Control
AVR	Automatic Voltage Regulator
CB	Circuit Breaker
CFL	Compact Fluorescent Lamp
COS	Change Over Switch
CT	Current Transformer
CSS	Compact Substation
CVT	Capacitive Voltage Transformer

DB	Distribution Board
DC	Direct Current
DCDB	Direct Current Distribution Board
DOL	Direct On Line
ELCB	Earth Leakage Circuit Breaker
ELR	Earth Leakage Relay
GCP	Generator Control Panel
GI	Galvanised Iron
IR	Insulation Resistance
kV	kilo Volt
kVA	kilo Volt Ampere
kVAr	kilo Volt Ampere reactive
kW	kilo Watt
kWh	kilo Watt hour
LDB	Lighting Distribution Board
LED	Light Emitting Diode
HT	High-tension
LT	Low Tension
LV	Low Voltage
LSIG	Long Time, Short Time, Instantaneous and Ground Fault
MCB	Miniature Circuit Breaker
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
MES	Military Engineering Service
MSB	Main Switch Board
MVA	Mega Volt Ampere
MW	Mega Watt
PDB	Power Distribution Board
PF	Power Factor
PI	Polarization Index

PLC	Programmable Logic Control
PT	Potential Transformer
PVC	Poly Vinyl Chloride
RCCB	Residual Current Circuit Breaker
REF	Restricted Earth Fault
RTD	Resistance Temperature Device
SCADA	Supervisory Control and Data Acquisition
SDF	Switch Disconnecter Fuse
SF6	Sulphur Hexa Fluoride
SLD	Single Line Diagram
SSB	Sub Switch Board
THD	Total Harmonic Distortion
TOD	Time of Day
UG	Under Ground
UPS	Uninterrupted Power Supply
USS	Unitised Sub Station
VA	Volt Ampere
VT	Voltage Transformer
VCB	Vacuum Circuit Breaker
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
WTI	Winding Temperature Indicator
XLPE	Cross Linked Poly Ethylene
KSTD	Kerala State Tourism Department
SCADA	Supervisory Control and Data Acquisition System

C1304 EQUIPMENT TECHNICAL SPECIFICATION

- C1304.1 110KV Receiving station (MES)
- C1304.1.1 110KV equipment such as Isolator, Breaker, CT, PT/CVT, Lightning arrester and 10/12.5MVA power transformer will be installed in the outdoor area of the 110KV MES Receiving station. Detailed design calculation, equipment sizing calculation, layout drawing, foundation and structural drawing to be provided. Fault level calculation to be prepared and submitted for approval for the complete electrical distribution system and accordingly the equipment to be sized.
- C1304.1.2 110KV metering bay as per KSEB standard with all measuring and control equipment.
- C1304.1.3 The Supervisory Control and Data Acquisition (SCADA) System is to be provided to supervise, control and acquire the various data from the 110kV & 11KV MES substation equipment.
- C1304.1.4 All the 110KV equipment and 11KV equipment shall be suitable to interface with the SCADA system.
- C1304.1.5 SCADA system shall be interfaced with the existing SCADA system in the North jetty.
- C1304.1.6 Design, supply and installation of complete switch yard civil work, structural work, fencing work, coarse aggregates etc. shall be in the scope of contractor.
- C1304.1.7 MES substation also contain the indoor 11kV Panel boards including bus coupler panel board. North jetty substation receives 11kV supply from the MES 11kV switchboard through Aluminium cable.
- C1304.2 110 kV outdoor SF6 circuit breaker
- C1304.3 Scope
- C1304.3.1 This specification covers requirements of 110kV outdoor SF6 circuit breaker.
- C1304.4 Codes and Standards
- C1304.4.1 The design, material, construction, manufacture, inspection, testing and performance of outdoor high voltage circuit breaker shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed
- C1304.4.2 Circuit breakers shall conform to the latest applicable standards. In case of conflict between the standards and this specification, this specification shall govern.

IS:2099 - Bushings for alternating voltages above 1000 V

IS:2629 - Recommended practice for hot-dip galvanizing on iron and steel

IS:2633 - Methods for testing uniformity of coating of zinc coated articles

IS:13118 - High Voltage alternating - current circuit breakers

IEC:62271 - HVAC circuit breakers

IEC:137 - Bushings for Alternating Voltages above 1000 V

IEC:376 - Specification and acceptance of new sulphur hexafluoride

C1304.5 Construction Feature

C1304.5.1 SF6 circuit breakers shall be of single pressure type and shall utilise puffer cylinder for interrupting circuit currents. In the live tank type of construction, the tank containing SF6 gas and the interrupters, which is at the potential of the circuit to which the circuit breaker is connected when the breaker is in service, shall be insulated from earth by providing suitable support insulators. SF6 gas shall serve as the quenching medium and insulation between open contacts of the circuit breaker. SF6 circuit breaker pole shall be provided with self-contained gas system. The service connections for gas handling shall be located on each pole tank to facilitate servicing. Unit type gas handling system shall be provided for above purpose. The SF6 gas supplied shall conform to IEC-376 specification.

C1304.6 Operating Mechanism

C1304.6.1 Provision for closing (if available as standard feature) and tripping shall be provided in the breaker control cabinet for maintenance and emergency operation. This device shall be so interlocked that while it is in service, the breaker cannot be operated from remote.

C1304.6.2 Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils, for which two nos. shunt trip coils shall be provided. Provision shall be made for local electrical control. Local / Remote selector switch shall be provided in the operating mechanism cubicle.

C1304.6.3 Closing release shall operate correctly at all values of voltage between 85% to 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 at all values of supply voltage between 70% and 110% of rated voltage.

C1304.6.4 Circuit breaker operating mechanisms capable of storing energy for at least two complete closing and tripping operations.

C1304.6.5 Each mechanism shall have an operation counter.

- C1304.6.6 The operating mechanism shall be mounted and enclosed in a weather-proof, vermin proof, sheet steel cabinet of not less than 2 mm thick conforming to IP55. The cabinet shall also house relays, control and auxiliary equipment of each breaker and for terminating all control, alarm and auxiliary circuits. It shall be provided with hinged doors with provision for locking and removable gland plates to be drilled at site. Inspection window shall be provided for observation of the instruments without opening the cabinet. It shall be mounted so as to provide convenient operation from ground level.
- C1304.6.7 A mechanical indicator shall be provided inside the operating mechanism box to show open and closed positions where it will be visible through a glass window to a man standing on the ground with the mechanism housing closed.
- C1304.6.8 The cabinet shall be fitted with a thermostatically controlled anti condensation heater, a 15A socket and switch and a cubicle lamp suitable for operation on 240V, 50 Hz supply.
- C1304.6.9 All controls, gauges, relays, valves, hard drawn copper piping and all other accessories shall be provided including the following:
- C1304.6.10 Low pressure alarm and lock out relay with adjustable pressure setting suitable for operation on the specified DC supply.
- C1304.6.11 A No-volt relay for remote indication of loss of compressor motor supply
- C1304.7 Two nos. independent trip coils
- C1304.7.1 Spring Operated Mechanism
- C1304.7.2 Spring operated mechanism, if offered, shall be complete with motor, opening / closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.
- C1304.7.3 After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible.
- C1304.7.4 Breaker operation shall be independent of the motor that shall be used solely for compressing the closing spring.
- C1304.7.5 Closing action of the circuit breaker shall compress the opening spring ready for tripping.
- C1304.7.6 When closing springs are discharged, after closing the breaker, closing springs shall automatically be charged for the next operation. Facility for manual charging of closing springs shall be provided.
- C1304.7.7 The time required to charge the closing spring after the closing operation shall not exceed 10 seconds.
- C1304.7.8 Under-voltage alarm relay to permit remote indication of loss of circuit supply to the spring charged motor and controls.
- C1304.7.9 Spring charge indicator to indicate the state of energy stores in the system.
- C1304.7.10 The spring charging motor shall be suitable for operation on 240V AC and 110V DC supply.
- C1304.8 Bushings

- C1304.8.1 Porcelain used for the manufacture of bushing shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Bushings and insulators shall have creepage distance to suit heavily polluted atmosphere.
- C1304.8.2 Glazing of the porcelain shall be of uniform brown colour free from blisters, burns and similar other defects. Bushings shall be designed to have ample mechanical strength and rigidity for the conditions under which they will be used. All bushings of identical ratings shall be interchangeable.
- C1304.8.3 Puncture strength of bushings shall be greater than the dry flashover value. When operating at normal rated voltage, there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the bushings when operating at the normal rated voltage.
- C1304.8.4 All iron parts shall be hot dip galvanised and all joints shall be air-tight. Surface of the joints shall be trued-up, porcelain parts by grinding and metal parts by machining. Bushing design shall be so as to ensure a uniform compressive pressure on the joints.
- C1304.8.5 All current carrying contact surfaces shall be silver faced. Silver facing shall not be less than one mil. in thickness.
- C1304.8.6 Bushings shall satisfactorily withstand the insulation level specified in relevant standards.
- C1304.9 Contacts
- C1304.9.1 Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall be adjustable to allow for wear, easily replaceable and shall have minimum of movable parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear.
- C1304.9.2 Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced or have tungsten alloy tipping.
- C1304.9.3 Positive mechanical interconnection shall be provided between interrupting contacts, resistor switches (when used), blast valve mechanism, if any, to ensure maximum operating reliability and retention timing.
- C1304.9.4 If multi-break interrupts are used, they shall be so designed and augmented that a fairly uniform voltage distribution is developed across them.
- C1304.10 Terminals
- C1304.10.1 Two clamp type earthing terminals each suitable for clamping earthing conductor shall be provided on each circuit breaker.
- C1304.11 Interlock

C1304.11.1 Key release mechanical interlocks shall be incorporated in the operating mechanism for interlocking with the associated isolators, so that operation of the circuit breaker is dependent on a “Key-trapped” situation. In addition, electrical interlocks with associated isolators shall be provided.

C1304.12 Additional Requirements

- Circuit breakers shall be of restrike free.
- Circuit breakers shall be capable of clearing short line faults with the same impedance behind the bus corresponding to the rated fault current.
- Circuit breakers shall be capable of breaking 25% of rated fault current at twice rated voltage under out of phase conditions as per standards specified.
- The manufacturer shall furnish the design features provided to effectively deal with:
 - Breaking of inductive currents and capacitive currents.
 - Charging of long lines and cables.
 - Clearing developing faults within the full rating of the breaker.
 - Opening on phase opposition.

C1304.13 Name Plate

- Each breaker shall be provided with a name plate in English, with data indelibly marked on it like Sl.no. Type, rated voltage, current, frequency, breaking capacity, eight, insulation level, rated short time current etc.
- Fittings and Accessories:
 - A partial list of some of the major fittings and the accessories to be furnished by the SUPPLIER as an integral part of the equipment is given below. Number and exact location of these parts shall be indicated in the Bid.
 - Operating mechanism housing complete with Padlocks and duplicate keys.
 - Space heaters equipped with automatic thermostatic control.
 - Local / Remote changeover switch.
 - Manually operated tripping push button / lever (mechanical) conveniently located to trip all three phases simultaneously.
 - Operation counter.
 - Terminal boards with minimum 6 spare terminals.
 - Control switches to cut off control power supplies.
 - Fuses as required.
 - Two earthing terminals.

- Auxiliary relays required for satisfactory operation
- Motor contactor with thermal release for spring charging motor.
- Breaker local control switch, 3 pin 15 A socket outlet and cubicle lamp
- Miscellaneous Accessories

C1304.14 Floor clamps

- Earthing pads (two).
- Hand operated lifting and lowering devices.
- Manually operated device for breaker closing under failure of normal power
- Foundation templates.
- Foundation bolts.
- Steel frames for frame mounted breakers.
- Under carriage with flanged rollers and rail fixing clamps for rail mounted breakers.
- Gas pressure detector.
- Position indicator.
- Spare Parts:
 - The Supplier shall furnish detailed list of spares as per his recommendations and quote separately for the same with their suggested quantities.
- Tests and Test Reports
 - The Purchaser shall witness all routine tests on free of cost.
- 110/11 KV Power Transformer

C1304.15 Scope

C1304.15.1 This specification covers requirements of 110/11 kV, 10/12.5MVA outdoor power transformer.

C1304.16 Construction Feature

C1304.16.1 The Power Transformers shall be Core Type, Oil Immersed with ONAN/ONAF cooling and suitable for Outdoor installation. The transformers shall be complete with standard accessories and equipped with the following protective devices: - Buchholz relay with double floats, one for alarm and one for trip. Dial type Thermometers with alarm and trip contacts for oil and winding. Magnetic Type Oil Level Gauge with alarm contacts, OLTC, RTCC. The leads from all the protective devices mentioned above shall be brought out to a weatherproof marshalling box mounted on the transformer.

C1304.16.2 Nitrogen Injection Fire Protection System (NIFPS) to be provided for power transformers – 10/12.5MVA . NIFP system shall be provided with automatic

control for fire prevention and fire extinction. The system shall be tested by UL, FM, LPCB or national testing body of BIS accredited laboratory's Test Report required. NIFPS shall have provision for AI / DI / Communication for Information / Records / Logging in SCADA of plant.

C1305 SPECIFICATION

C1305.1 Transformer Specification:

Conformation to Specification:	IS 2026-1977 (Part I to V)
Type:	Two winding Transformer
Primary Voltage:	110KV
Secondary Voltage:	11KV
No. of Phases:	3
Frequency:	50HZ
Power Rating:	10 /12.5MVA
Transformer Connection:	Dyn11
Winding:	Copper
Type of cooling:	ONAN/ONAF
Tap Changer:	On load tap changer
Application:	Outdoor application
Cooling Equipment:	Radiator
Primary Terminals Type:	CondenserTypeBushingasperIS:2099
Secondary Terminal:	Outdoor terminal bushing
No. of Taps:	Vendor to specify
Suitability:	To suit Parallel operation Max. ambient temperature: 50°C
% Impedance at rated current:	Vendor to specify
Value of load and no load loss:	Vendor to specify Details of aux.
Power supply:	Vendor to specify Insulation level for each winding (Power frequency & Impulse): Vendor to specify

- Protection Devices and accessories:
- Oil surge relay / Buchholz relay
- Pressure relief valve/ Explosion vent
- Dehydrating Breather
- Temperature Indicator to indicate oil and winding temperature and to operate an alarm/trip circuit at pre-set temperatures.
- Oil level indicators
- Insulating oil as per IS:335-1993.
- Conservator tank

- Oil drain Valve
- Air release device
- Oil filling hole with cover
- Filter Valve
- Lifting lugs
- Jacking lugs
- Rollers/skids
- Inspection cover
- Rating Plate
- Terminal Marking Plate
- Two Earthing Terminals
- Nitrogen Fire fighting system

C1305.1.1 The power transformer (10/12.5MVA, 110/11kV) secondary side neutral shall be resistance earthed in order to limit the 11kV system earth faults to low values such as to limit excessive damage to 11kV equipment.

C1305.2 Tests and Measurements

C1305.2.1 **Type Test:** In addition to routine Tests mentioned above the transformer shall be subjected to all kinds of Type in accordance with Relevant I.S. (IS:2026) with latest amendment if any. Type test certificates to be submitted for Employer approval.

C1305.2.2 **Routine Tests:** All transformers shall be subjected to the following routine tests at the manufacturer's works. The tests shall be carried out in accordance with the details specified in IS:2026.

- (i) Measurement of winding resistance.
- (ii) Measurement of turns ratio for all sets windings on each tap
- (iii) Polarity and phase vector relationship.
- (iv) Measurement of no load loss and no load current.
- (v) Measurement of impedance voltage at normal, maximum and minimum tap
- (vi) Measurement of insulation resistance between windings and between windings and earth.
- (vii) Measurement of load loss.
- (viii) Induced over voltage withstand test.
- (ix) Separate source voltage withstand test.
- (x) Oil Leakage gas collection, oil surge and voltage test on gas and oil actuated relay for on load tap changer.
- (xi) Magnetic balance test.

(xii) Testing of Phase & Neutral C.T., as applicable, in accordance with provisions in the relevant I.S.

(xiii) Oil leakage test of transformer tanks at a pressure equals to the normal pressure plus 35 KN/ sq. m measured at the base of tank.

C1305.2.3 **INSPECTION AND TESTING:** Inspection and testing as already mentioned the equipment shall be subjected to routine and other acceptance tests as per provisions in the relevant I.S. The Client reserves the right to send its Employers if so desires to witness manufacturing process and to reject either raw materials or finished products found to be not complying with the requirement of the specification and also shall have the right to select any/all equipment from the lot offered for tests.

C1305.2.4 The manufacturer shall give at least (15) fifteen days" advance notice regarding readiness of such inspection and testing and shall submit six sets of the works test certificates of the materials/equipment offered for inspection and testing indicating probable date of inspection and testing.

C1305.2.5 The Supplier shall arrange all possible facilities for such inspection and testing at any time during the course of manufacture free of cost.

C1305.3 Spare Parts

C1305.3.1 The Tenderer shall submit a recommended list of spare parts for five years of operation along with item wise price for each item of spares.

C1306 RELAY AND CONTROL PANELS

C1306.1 Scope

C1306.1.1 This specification covers the requirements of relay, metering and control panels and the associated equipment mounted therein.

C1306.1.2 The scope of design, manufacture, testing and supply of equipment covered under this specification shall include but not necessarily be limited to the following:

C1306.1.3 Design, Engineering and fabrication of panels as per the specifications.

C1306.1.4 Supply and mounting of all the equipment and auxiliary equipment like auxiliary relays, test switches, test blocks, plugs, timers, indicating instruments, etc., necessary for satisfactory functioning of the control and protection system.

C1306.1.5 The protection system shall be provided with additional auxiliary contacts to integrate system with the Data Acquisition system.

C1306.1.6 All internal wiring between all equipment up to the terminal blocks and the inter-panel wiring.

C1306.1.7 Preparation and furnishing of all data / drawings / documents as per the specifications.

C1306.1.8 Testing at works of the panels and the mounted equipment.

C1306.2 Codes and Standards

C1306.2.1 The design, manufacture and performance of equipment covered by this specification shall conform to the relevant Indian Standards and Codes. Where

Indian Standards are not available, they shall conform to relevant British, IEC and American Standards.

C1306.2.2 The equipment shall conform to following standards in particular.

- IS:375 - Marking and arrangement of switchgear, bus bar, main connections and auxiliary wiring.
- IS:722 - AC electricity meters
- IS:1248 - Direct acting indicating analogue electrical measuring instruments and their accessories
- IS:2208 - HRC cartridge fuse links for voltage upto 650 V.
- IS:2705 - Current transformers
- IS:3156 - Voltage transformers
- IS:3202 - Code of practice for climate proofing of electrical equipment.
- IS:3231 - Electrical relays for power system protection
- IEC:44 - Instrument Transformers
- IEC:185 - Current Transformers
- IEC:186 - Potential Transformers
- IEC:255 - Electrical Relays
- IEC:1036 - Static Meters

C1307 DESIGN REQUIREMENT

C1307.1 Constructional Features

C1307.1.1 The panels shall be 'Simplex' type.

C1307.1.2 Panels shall be sheet steel enclosed dust and vermin proof type. Panels shall be floor mounting, free standing, formed on a framework of standard sections. The enclosure shall be of cold rolled sheet of 3 mm for front and back and 2.5 mm thick for rest. Panel supporting structure shall be so designed to form a rigid structure.

C1307.1.3 All doors and openings shall be provided with neoprene gaskets.

C1307.1.4 The panels shall be suitable to be installed on a base frame supplied in one piece along with foundation bolts. Amply dimensioned oblong holes shall be provided at the bottom of all the panels for their installation on base frame in addition the panels shall have an additional base channel at the bottom with smooth surface. Anti-vibration type mounting shall be provided.

C1307.1.5 A suitable removable undrilled gland plate shall be provided for cable entry from bottom. Suitable double compression type cable glands for control cables of required size quantity and material shall be included in the scope of supply.

C1307.1.6 The degree of protection of the panels shall be IP52.

C1307.2 Mounting

- C1307.2.1 All instrument and control gears and relays shall be mounted on the front All equipment shall be flush or semi-flush type.
- C1307.2.2 Checking and removal of components shall be possible without disturbing the adjacent equipment. It shall be possible to set all the measuring relays "insitu".All mounted equipment inside the panels shall have "identification tags of self-sticking Engraved tapes; in addition, identification numbers shall be painted on panel wall to give permanent identification mark. The mounting of terminal blocks and any other auxiliary equipment such as transducers, interposing CTs etc. shall be done in such a way so as to be readily accessible but without impeding the access to internal wiring and components.
- C1307.2.3 The centre line of switches push buttons and indicating lamps shall be not less than 750 mm from the bottom of the panel. The centre line of relays, meters, recorders shall not be less than 450 mm from bottom of the panel. All switches, push buttons, indicating lamps, relays, etc. shall be neatly arranged in a matching manner.
- C1307.2.4 The control panels shall be matched with other panels in dimension, colour and mimic.
- C1307.3 Type of Panels
- C1307.3.1 The simplex panels shall consist of vertical front panels with mounted equipment and rear wiring access. Doors shall have handles with locking facility.
- C1307.4 Wiring
- C1307.4.1 All wiring shall be done with PVC insulated, 650V grade, single-core multi strands (minimum 3 strands) annealed copper conductors suitable for temperature and humidity specified. The cross section of the wires for voltage, current and control circuits shall be 2.5 Sq.mm and that for the alarm circuits shall be 1.5 Sq.mm. The wires shall be vermin proof and shall be laid in plastic troughs. Respective phase colour shall be used for PT & CT circuits. Black colour shall be used for auxiliary AC supply & neutral of CT & PT circuits and grey colour shall be used for DC control circuits.
- C1307.4.2 Each wire shall be identified at both ends with wire numbers by means of PVC ferrules. Colour coding for the wires shall be as per IS:375. Each cable shall be identified with aluminium tags.
- C1307.4.3 Minimum 20% spare terminals shall be provided on the panels.
- C1307.4.4 The terminals shall be suitable to receive crimped wires to give positive connection. All terminals shall be properly shrouded against accidental contact. Sufficient terminals shall be provided so that not more than one wire is connected to each terminal.
- C1307.4.5 The terminal blocks shall be 600V grade 10 amps rated, one piece moulded complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips.
- C1307.4.6 Terminal blocks for the CT and PT secondary leads shall be provided with test links and isolation facilities. Also CT secondary leads shall be provided with

short circuiting and earthing links. Test terminal blocks shall be provided in TVM / kWh circuits.

C1307.5 Painting

C1307.5.1 All metal surface shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surface shall be made free from all imperfections before undertaking finishing coat.

C1307.5.2 After preparation of the under surface, the relay and control panel shall be spray painted with two coats of final paint. Colour shade of final paint shall be pebble / flint grey, shade RAL 7032 with glossy finish and shall be duly approved by the PURCHASER before final painting is done. The finished panel shall be dried in stoving oven in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint etc. The SUPPLIER shall furnish painting procedure details along with the bids.

C1307.5.3 All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust corrosion. If these parts are moving element, then these shall be greased.

C1307.6 Earthing

C1307.6.1 The continuous earth bus of copper of suitable size as computed as per the fault level of the installation shall be provided running along full length of panel. However the minimum size of copper earth bus shall not be lesser than 25x3 mm. Suitable arrangement shall be provided at the two ends for connection to the plant earthing system.

C1307.6.2 Each panel and the equipment mounted on each panel shall be securely connected to the earth bus. For this purpose, the earth wire shall be looped from equipment to equipment and both ends of the earth wire shall be connected to the earth bus.

C1307.7 Space Heaters

C1307.7.1 Panel space heaters shall operate off 240V AC and shall be supplied complete with on-off switch, fuse and thermostat. A common thermostat shall be provided for the entire panel. The thermostat shall maintain the internal temperature above the ambient temperature to prevent moisture condensation.

C1307.8 Mimic

C1307.8.1 Mimic diagram shall be provided on panels. Mimic diagram shall be screwed on to the panels and shall be made of anodised aluminium or plastic of approved fast colour. The mimic shall be 10 mm wide for horizontal run and 5mm wide for vertical run.

C1307.8.2 Semaphore indicators used for isolator positions, they shall be so mounted in the mimic that isolator (or breaker) closed position shall complete the continuity of the mimic. The mimic diagram shall incorporate red and green lamps for isolator position indication and controlling switches with indicating lamps for breakers.

C1307.8.3 The colours for various voltages in the mimic diagram shall be as below.

Voltage Level	Mimic Colour	Shade as per IS:5
11 kV	Canary Yellow	309
110 kV	Signal Red	537

C1308 EQUIPMENT SPECIFICATIONS

C1308.1 Instruments

C1308.1.1 All instruments shall be switchboard type, back connected, flush mounted, dust tight and tropicalized. They shall be of square pattern and comply with IS:1248 and shall be of accuracy class 1.0. They shall have 90deg. scale range. All power measuring meters / transducers shall be suitable for measuring import & export parameters.

C1308.1.2 Zero adjustment for pointers shall be accessible from the front of the instruments. All auxiliary equipment such as shunts, transducers, interposing CT / PT etc. that are required shall be included in the scope of supply.

C1308.1.3 All instruments shall be subjected to an applied potential test of 2.0 kV for one minute. Wherever specified, digital meters shall be provided to indicate frequency and power factor parameters.

C1308.2 Frequency Meters

C1308.2.1 The Frequency Meters shall be long range, calibrated for 45-50-55 Hz. These shall be of digital type.

C1308.3 Ammeters, Voltmeters, KVAR meters, KVA meters

C1308.3.1 These shall be of moving iron type, with centre zero provision. The KVAR meter and KVA meter shall be suitable for measuring unbalanced loads on a 3- phase, 3 wire system.

C1308.3.2 The kW meter, digital type and voltmeter shall operate off PT secondary voltage of 110 V. These shall be suitable for export / import parameters.

C1308.3.3 kWh and kVARh meters shall be provided with a separate 3 phase 4 wire type test blocks for the testing of the meters without disturbing the CT and PT secondary connections.

C1308.4 Power Factor Meters

C1308.4.1 This meter shall be of digital and the range of pf meters shall be 0.5 - 1 - (-0.5).

C1308.4.2 These shall operate on 110V PT secondary.

C1308.4.3 This meter shall be suitable for measuring PF in four quadrants.

C1308.5 Transducers

C1308.5.1 Transducers with output of (4-20) mA shall be arranged for voltage, frequency, current, power factor, MW, MVA and MVAR for hooking up to SCADA system.

C1308.5.2 Transducers need not be provided wherever the analog signal could be made available from PQM meter.

- C1308.6 Indicating Lamps
- C1308.6.1 These shall be switchboard type of low power consumption, LED cluster type lamps and shall be supplied complete with necessary resistors. Lamps shall be provided with screwed translucent covers to diffuse light. The lamp covers shall preferably be unbreakable, moulded, heat resistant material and shall be provided with chromium plated bezels.
- C1308.7 Control Switches
- C1308.7.1 All control switches shall be rotary, back connected type having cam operation contact mechanism. Phosphor bronze contacts shall be used on switches.
- C1308.7.2 The handle of control switches used for circuit breaker operation shall turn clockwise for closing and anti-clockwise for tripping and shall be spring return to neutral from close / trip with lost motion device. Each switch shall be provided with external red and green indicating lamps.
- C1308.7.3 Ammeter selector switches shall be with make before break feature and shall have 3- position, suitable to read phase voltages.
- C1308.8 Control Devices
- C1308.8.1 All control devices shall be of MCB type. MCBs shall generally be mounted on the top half of the panels. All MCBs shall be provided with suitable identification labels.
- C1308.9 Annunciator
- C1308.9.1 Facia type microprocessor based annunciators shall be provided on the control panels for all alarm / trip functions of the system.
- C1308.9.2 Unless stated otherwise, the annunciators shall be suitable for operation with normally open fault contact which closes on a fault.
- C1308.9.3 One common audible alarm, one common acknowledge push button, one reset push button and one 'all lamp test' push button shall be provided common to all annunciators.
- C1308.9.4 DC supply failure indication shall be provided separately with DC under voltage relays with reverse flag indication. On failure of DC supply to the panel, a lamp and a horn with AC supply shall operate. There shall be provision for canceling AC horn. The DC bell and AC horn shall have distinctly separate tones.
- C1308.9.5 All transformer internal faults shall be hooked-up to annunciator and windows of 20% shall be provided as spare for Purchaser's use.
- C1308.9.6 Relays
- C1308.9.7 All relays shall be switchboard pattern, back connected draw out type suitable for flush mounting and fitted with dust tight covers. The relays conform to IS:3231 or BS:3950 and BS:142.
- C1308.9.8 A set of test block and test lead for necessary secondary injection tests shall be included. All relays in draw out cases shall have suitable spring-loaded contacts for inserting test block.
- C1308.9.9 Relays shall be provided with hand / auto reset type contacts and flag indicators. The flag indication shall be suitable for external hand resetting and

mechanically interlocked to prevent falling when relays is subjected to vibration. The rating of the auxiliary contacts shall not be less than 5 amp at 240V AC and 1.5 amp for 110V DC. Relay coils to be suitable for the specified DC voltage.

- C1308.9.10 The detailed lists of relays for each panel is listed elsewhere. The relays shall be supplied with the necessary accessories to make the system complete.
- C1308.9.11 Test terminal block shall be provided, wherever multifunction relays are envisaged.
- C1308.10 Name and Identity Plates
- C1308.10.1 All instruments, relays and other electrical devices mounted on the control panel shall be provided with plates bearing the manufacturer's name, serial number and the electrical rating data.
- C1308.10.2 Plastic plate at least 10 mm wide bearing suitable identification marks shall be fixed in the interior of the switchboard, at the test blocks, at the fuse blocks and at the cable terminals. Similar plates shall be fixed to the exterior of the switchboard in appropriate places to indicate the functions of control switches, push buttons, lamp and other equipment not incorporated in the mimic diagram.
- C1308.11 Auxiliary PT and CTs
- C1308.11.1 Necessary auxiliary potential transformers for open delta potential polarisation and auxiliary current transformers, wherever required, shall be included in supply.
- C1308.11.2 The instrument transformers shall have the required accuracy class and the same shall be specified in the offer.
- C1308.12 Tri-vector Metering for tariff purposes
- C1308.12.1 Integrating meters of the Tri-vector or equivalent types capable of indicating kWh, kVARH, kVAH directly shall be provided for measuring and recording grid parameters. Meters shall be suitable for measuring import as well as export parameters, including 'lag' and 'lead' functions for reactive kVARH for import & export
- C1308.12.2 They should be suitable for 3 phase, 4 wire 50 Hz circuits with unbalanced loading and with three elements connected to current and potential transformers of specified ratio.
- C1308.12.3 The tri-vector meters for tariff purposes shall be of digital type, class 0.5 accuracy with RS485 communication port.
- C1308.12.4 Test terminal blocks (TTB) shall be provided in the panels, wherever the tri-vector meters are installed.

C1309 DETAILS OF PROTECTIVE RELAYS

- C1309.1 Protections for Switchyard:
- C1309.1.1 Protection of the transformer shall be achieved through microprocessor based, composite protective digital relay to cover differential, restricted earth fault and over fluxing function. Alternatively, static / microprocessor based discrete relays can also be offered.

- C1309.1.2 All transformer in-built protective functions should be connected through individual auxiliary relays.
- C1309.1.3 Numeric relay to cover the following protective functions and features shall be envisaged:
- Directional over current and earth fault relays
 - Non-directional over current and earth fault relays for primary
 - Vector surge relay
 - Over and under voltage relay on EHV end
 - PT fuse failure relay
 - Breaker struck up protective relay
 - Trip Circuit Supervision
 - DC supply failure relay
 - Alpha numeric display
 - Communication port, RS485 interface
 - Necessary software, for processing of data
 - Event recording facility, for minimum of 5 events
- C1309.1.4 Additional discrete relays, with make & type as furnished in the list of approved makes, shall be provided for the following main functions (even if some of the protections are covered in the numeric / multifunction relays):
- Vector surge relay (microprocessor based)
 - Transformer HV side standby earth fault relay
 - Under and over voltage relays for 11 kV bus
 - Neutral displacement relay for 11 kV bus
 - Transformer LV side over current relays
 - 'No-volt' relay for circuit breaker interlocking
- C1309.2 Line Protections
- C1309.2.1 Numeric type distance relay to cover the following minimum protective functions and features shall be provided:
- Four zone distance protection, with polygonal and circular characteristics
 - Back-up over current and earth fault functions
 - Switch-on to fault blocking function
 - Circuit breaker struck-up protection
- C1310 TRIP CIRCUIT SUPERVISION**
- C1310.1 DC supply failure relay
- PT fuse failure blocking

- Fault locators
- Alpha numeric display
- Communication port, RS485 interface
- Necessary software, for processing of data
- Event recording facility, for minimum of 5 events

C1310.1.1 Additional discrete relays, with make & type as furnished in the list of approved makes, shall be provided for the following main functions (even if some of the protections are covered in the numeric / multifunction relays):

- Non-directional over current and earth fault relays
- Directional over current and earth fault relays
- No-volt' relay for circuit breaker interlocking

C1310.2 Inspection and Tests

C1310.2.1 Following tests shall be carried out on the control panel in the presence of Purchaser or his authorised representative:

- Checking of correctness of wiring of circuits and continuity.
- Electrical control, interlock and sequential operation test.
- High voltage test 2000 volts to earth for one minute.
- Insulation resistance of the complete wiring with all equipment mounted on the panels.
- Routine tests according to the standards followed by the manufacturer on the instruments, relays & other devices.
- DC tests

C1310.2.2 Certified copies of all routine test certificates shall be submitted to the purchaser before despatch for review by the Purchaser

C1310.3 Drawing and Data

C1310.3.1 Supplier shall furnish all the data / drawings / documents specified in the specifications for review by the Purchaser.

C1310.3.2 Supplier shall submit for Purchaser's approval the general arrangement drawings showing front, rear and side views, PT / CT connection drawings, AC / DC power diagrams, detailed bill of materials, interconnection and wiring diagrams, terminal arrangement drawings as well as other drawings which may be deemed necessary by the Purchaser. Approval of the GA drawing is required before the fabrication of panel starts. Approval of wiring and interconnection drawings is required before the manufacturer proceeds with the panel wiring. Programming listings for numeric type relays and relay setting format for all relays shall also be submitted for approval.

C1310.3.3 Final as-built drawings, catalogues of all relays / meters, O&M manuals and Instructions shall be furnished.

C1311 BUS BARS, INSULATORS AND ACCESSORIES

- C1311.1 Standards
- IS:398 Aluminium conductors for overhead transmission purposes.
 - IS:731 Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V.
 - IS:2121 Conductors and earth wire accessories for overhead power lines
 - IS:2544 Porcelain post-insulators for systems with nominal voltage greater than 1000 V
 - IS:2633 Methods for testing uniformity of coating of zinc coated articles
 - IS:4826 Hot-dipped galvanised coatings on round steel wires
 - IS:5082 Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes
- C1311.2 General Requirement
- C1311.2.1 Busbars and electrical connections in the outdoor area shall be of aluminium.
 - C1311.2.2 Busbars shall be in continuous lengths between supports and provision shall be made for expansion and contraction with variation in conductor temperature including sliding supports where necessary. Materials used for busbars and connections shall be stressed not more than forty (40) percent of their elastic limits. All joints shall be made only at equipment connection points. Straight joints should be avoided totally.
 - C1311.2.3 The busbars, insulators and connectors shall be mechanically dimensioned to safely withstand the effect of temperature, wind load, tensile forces and movement of connections as well as short circuit forces.
 - C1311.2.4 Connections between two (2) dissimilar metals shall be of bimetallic type.
 - C1311.2.5 Unless otherwise approved, busbars and connections shall be so arranged and supported that under all circumstances, including short circuit conditions, the clearances specified shall be maintained.
 - C1311.2.6 The temperature rise of conductors and connections shall not exceed 35 deg. C over 50°C design ambient.
 - C1311.2.7 All connectors for busbars, equipment etc. shall be of suitable design to permit easy dismantling for maintenance purposes.
- C1311.3 Stranded Conductor
- C1311.3.1 The stranded conductors shall be ACSR, and shall be drawn from ninety nine and half (99.5) percent pure electrolytic aluminium rods with 60% IACS conductivity and shall conform to IS:398.
 - C1311.3.2 The surface shall be clean, dry and free from grease and burns.

- C1311.3.3 Steel wires used in ACSR conductors shall be hot dip galvanized. Zinc coating shall be uniform and even.
- C1311.3.4 Grease used shall be chemically neutral with respect to aluminium, zinc and steel.
- C1311.4 Insulators and Hardware
- C1311.4.1 The porcelain used for string and post insulators shall be sound, free from defects, thoroughly vitrified and smoothly glazed. Insulators shall have a good lustre and of uniform brown colour. The glaze shall be unaffected by sudden changes in temperature and by atmospheric pollution. Insulators shall have creepage distance to suit heavily polluted atmosphere.
- C1311.4.2 Insulators shall be designed to avoid excessive concentration of electrical stresses in any section or across leakage surface. Design feature shall be such as to reduce radio interference level.
- C1311.4.3 The string and post insulators shall have the best electrical and mechanical characteristics.
- C1311.4.4 Strain strings shall comprise the conventional ball and socket type disc insulators. Individual insulators as well as strings of the same type shall be interchangeable with one another. The locking clips shall be made of phosphur bronze and shall provide positive locking of the coupling.
- C1311.4.5 **All metal parts shall be made of good commercial grade malleable iron or open hearth** or electric furnace steel, hot dip galvanized conforming to IS:2633. Castings shall be free from blowholes, cracks and other similar defects.
- C1311.4.6 The ultimate breaking strength of the insulator shall be decided considering a factor of safety of 2.5 (minimum) under short circuit conditions.
- C1311.5 Clamps, Connectors, Fittings and Accessories
- C1311.5.1 The connectors and clamps shall be made of aluminium alloy casting conforming to A6 of IS:617. All bolts, nuts and washers shall be of mild steel and hot dip galvanized. No part of a clamp or connector shall be less than 10 mm thick.
- C1311.5.2 All castings shall be free from blowholes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- C1311.5.3 The current bearing capacity of each connector shall be equal to or greater than that of the conductor size for which the connector is designed. The bore of each connector shall be of the correct diameter to fit the conductor size specified. Bores intended for a range of conductor sizes will not be permitted.
- C1311.5.4 The size and shape of each connector in any assembly or location shall be free from visual and audible corona.
- C1311.5.5 The hardware used in the connectors, clamps etc. shall have protective coating of approved type to eliminate galvanic action with the main body, wherever required.
- C1311.5.6 The connections shall be such that the contact surfaces are more or less sealed from atmosphere and are not subjected to weathering.

- C1311.5.7 The connectors, clamps and accessories shall be such that the contact pressure is uniformly distributed over the whole contact surface and no stress concentration develops anywhere. In order to achieve this a torque wrench shall be used for tightening all bolts in accordance with manufacturer's recommended torque. Bolts shall be used as clamping devices and not as current carrying parts.
- C1311.5.8 Tension clamps shall be designed to avoid any possibility of damage or deformation of the stranded conductor and separating the individual strands. Wherever possible compression type fittings shall be used on stranded conductors.
- C1311.5.9 All current carrying parts shall have minimum contact resistance.
- C1311.6 110kV Outdoor Current Transformer:
- C1311.7 Scope
- C1311.7.1 This specification covers for design, manufacture, inspection, testing before despatch, packing and delivery, installation, testing and commissioning of 110KV Outdoor Current Transformers along with all accessories.
- C1311.8 Standards:
- The following standards shall be followed while designing the CT.
- IS:2705: Current Transformers**
- IS:2099: High Voltage Porcelain Bushings
- IS:3347: Dimensions of porcelain for transformer
- IS:2165: Insulation co-ordination for equipments of 110KV and above.
- IS:335: Insulating oil for transformer
- IS:2071: Method of high voltage testing
- IS:2147: Degree of protection provided by enclosure for low voltage switch gear and control**
- IS:185: Current Transformers
- IEC:60: High Voltage testing techniques
- IEC: 171: Insulation co-ordination
- IEC:44(4): Instrument transformer measurement of P. Ds**
- IEC:270: Partial discharge measurement**
- IEC:8263: Method for RIV test on high voltage insulators.
- IEC:60044-1: Current Transformers.
- C1311.8.1 Besides the above, the standard minimum safety clearances stipulated in CEA safety regulation shall also be complied with.
- C1311.9 General Technical Requirements
- C1311.9.1 Current Transformers shall have single primary either ring type, or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom. These secondary terminals shall be

terminated to stud type non disconnecting terminal blocks inside the terminal box. The primary winding should be housed in rigid metallic shell. The winding assembly should be held firmly and for this purpose suitable clamping arrangement at the bottom shall be provided and explained through a sketch. Firm clamping arrangement is a must and holding of winding using nylon rope etc. shall not be acceptable. In case "Bar primary" inverted type current

- C1311.9.2 The secondary shall be totally encased in metallic shielding providing uniform equipotential surface for even electric field distribution
- C1311.9.3 The lowest part of the insulation assembly shall be properly 'secured to avoid any risk of damage due to transportation stresses.
- C1311.9.4 The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome.
- C1311.9.5 Nitrogen if used for hermetic sealing (in case of live tank design) should not come in direct contact with oil.
- C1311.9.6 Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.
- C1311.9.7 Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent better alloys. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios with specified CT parameters.
- C1311.9.8 The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short circuiting and grounding of CT secondary terminals.
- C1311.9.9 Current Transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
- C1311.9.10 For 145 kV Class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs as specified.
- C1311.9.11 For 145 kV Current Transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 10% to 100% of rated current in case of metering CTs and up to the accuracy limit factor/ knee point voltage in case of relaying CTs.
- C1311.9.12 The Current Transformer shall be suitable for horizontal transportation. It shall be ensured that the CT is able to withstand all the stresses imposed on it while transporting and there shall be no damage in transit the contractor shall submit the details of packing design to the purchaser for review.
- C1311.9.13 For 145 kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core.
- C1311.9.14 The wiring diagram plate for the interconnections of the 3 single phase CTs shall be provided inside the marshalling / junction box.
- C1311.9.15 The Current Transformers should be suitable for mounting on lattice support structure to be provided by the purchaser.

- C1311.9.16 The CT shall be designed as to achieve the minimum risks of explosion in service. Bidder/Manufacturer shall bring out in his offer, the measures taken to achieve this.
- C1311.9.17 145kV Current Transformers shall be suitable for high speed auto reclosing.
- C1311.9.18 The insulation of the current transformer shall be designed that the internal insulation shall have higher electrical withstand capability than the external insulation. The designed dielectric withstand values of external and internal insulations shall be clearly brought out in the guaranteed technical particulars. The dielectric with stand values specified in the specification are meant for the fully assembled Current Transformers.
- C1311.9.19 The porcelain housing shall be made of homogeneous, vitreous, porcelain of high mechanical and dielectric strength, glazing of porcelain shall be of uniform brown or dark brown colour with smooth surface arranged to shed away rain water or condensed water particles (fog). The profile of porcelain shall be aerodynamic type as per IEC-815.
- C1311.9.20 Current Transformers supplied with Nitrogen cushion for compensation of oil volume variation shall be provided with prismatic type oil sight window at suitable location so that the oil level is clearly visible to naked eye to an observer standing at ground level. If metal bellow is used for the above purpose a ground glass window /bellow level indicator shall be provided to monitor the position of metal bellow. Oil minimum and maximum level may be engraved and painted.
- C1311.9.21 All exposed Ferrous parts including Tank of the Current Transformer. Structural steel, pipes, rods, levers, linkages, nuts & bolts used etc shall be hot dip galvanized as per IS: 2629 and IS: 2633.
- C1311.9.22 Insulating oil required for first filling of the Current Transformer shall be covered in Bidder's scope of supply. The oil shall meet the requirements of latest edition of IS:335.
- C1311.10 Acceptance and Routine Tests:
- C1311.10.1 All acceptance and routine tests as stipulated in the IEC 60044-1 of latest version shall be carried out by the supplier in presence of Employer representative. In addition, the capacitance and tan delta tests should also be conducted. The measured values shall be engraved in the name plate.

C1312 110kV POTENTIAL TRANSFORMER

- C1312.1 Scope
- C1312.1.1 This scope covers for design, manufacture, inspection, testing before dispatch, packing and delivery at site, installation, testing and commissioning of 110KV Potential Transformers along with all accessories with its terminal box and a common junction box, terminal connector specified herein for Protection and Metering services with suitable mounting structure.
- C1312.2 Standards
- C1312.2.1 Unless otherwise specified elsewhere in the specification, the Electro Magnetic Voltage Transformers shall conform to the latest revisions and amendments

thereof the IS:3156 and IEC Standards. Besides the above the standard minimum safety clearances stipulated in CEA regulations shall also be complied with. All clearance of live parts between phases and to earthed metal parts of equipment's shall be adequate for maximum service voltage or normal plus 10% and shall conform to IS:3156 of the latest issue unless specified otherwise.

C1312.3 General Technical Requirements

C1312.3.1 The insulation of the Potential Transformer shall be designed such that the internal insulation shall have higher electrical withstand capability than the external insulation. The designed dielectric withstand values of external and internal insulations shall be clearly brought out in the guaranteed technical particulars. The dielectric with stand values specified in the specification are meant for the fully assembled Potential Transformers.

C1312.3.2 The porcelain housing shall be made of homogeneous, vitreous, porcelain of high mechanical and dielectric strength, glazing of porcelain shall be of uniform brown or dark brown colour with a 261 smooth surface arranged to shed away rain water or condensed water particles (fog). The profile of porcelain shall be aerodynamic type as per IEC-815.

C1312.3.3 Insulating oil required for first filling of the Potential Transformer shall be covered in Bidder's scope of supply. The oil shall meet the requirements of latest edition of IS:335.

C1312.3.4 All interiors and exteriors of enclosures, cabinets and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, grease and other adhering foreign matter and the surfaces treated by phosphating (e.g seven tank phosphating sequence). After such preparation of surfaces, two coats of zinc oxide primer shall be given by suitable stoving and air drying before final painting. Colour of the final paints shall be shade No.697 of IS-5. The finally painted cubicle shall present aesthetically pleasing appearance and shall be free from any dent or uneven surface. Complete details of painting, galvanizing and climate proofing of the equipment shall be furnished in the offer. Paint inside the metallic housing shall be of anti-condensation type and the paint on outside surfaces shall be suitable for outdoor installation. All components shall be given adequate treatment of climate proofing as per IS-3202 so as to withstand corrosive and severe service conditions. All metal parts not suitable for painting such as structural steel, pipes levers, linkages nuts and bolts used in other than current path etc. shall be hot dip galvanized as per IS-2629.

C1312.3.5 Insulating oil required for first filling of the Potential Transformer shall be covered in Bidder's scope of supply. The oil shall meet the requirements of latest edition of IS:335.

C1312.3.6 Potential Transformers supplied with Nitrogen cushion for compensation of oil volume variation shall be provided with prismatic type oil sight window at suitable location so that the oil level is clearly visible to naked eye to an observer standing at ground level. If metal bellow is used for the above purpose a ground glass window /bellow level indicator shall be provided to monitor the position of metal bellow. Oil minimum and maximum level may be engraved and painted.

C1312.4 Acceptance and Routine Tests:

C1312.4.1 All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in presence of Employer's representative.

C1312.4.2 Routine Test: Following routine tests shall be carried out in the presence of Employer's representative. (i) Verification of terminal marking and polarity. (ii) High Voltage power frequency tests on primary windings. (iii) High Voltage power frequency tests on secondary windings. (iv) Partial discharge measurement. (v) Determination of errors according to the requirement of appropriate accuracy class. (vi) Tan delta measurement.

C1313 SPECIFICATION FOR ISOLATORS

C1313.1 Scope

C1313.1.1 This scope covers for design, manufacture, inspection, testing before dispatch, packing and delivery at site, installation, testing and commissioning of 110kV Isolator along with all accessories with its terminal box and a junction box, terminal connector specified herein for Protection services with suitable mounting structure.

C1313.2 Standards

IS:2544 - Porcelain post insulators for systems with nominal voltage greater than 1000 V.

IS:9921 - Alternating current dis-connectors (isolators) and earthing switches for voltages above 1000 V.

IEC:129 - Alternating current dis-connectors (isolators) and earthing switches

C1313.3 General Requirements

C1313.3.1 The isolators shall be three pole, gang operated, horizontally mounted, centre pole rotating, operated manually. The isolator shall be complete with bases, insulators, contacts, terminals, blades, operating mechanisms and mounting poles. All switch bases, operating mechanisms, rods, and other steel parts shall be hot dip galvanized.

C1313.3.2 Isolator and earth switch shall be equipped with all necessary linkages, clamps, couplings, operating pipes and handle supporting brackets, guide blades, auxiliary switches, earth braids and other miscellaneous items required to make complete installation. All operating rods and levers shall be cut to length and all machining operations and threading shall be completed in the factory.

C1313.3.3 The isolator and the earth switch shall be mechanically designed to safely withstand the effects of temperature, wind load, tensile forces and movement of connections, as well as short circuit forces.

C1313.3.4 The isolator blades and all conducting parts shall be of high conductivity copper or aluminium alloy. Bolts, screws and pins shall be provided with lock washers, keys or equivalent locking facilities. All bearings shall be such that no lubrication or maintenance is required.

C1313.3.5 During the course of normal operation, it is likely that the isolator may be left in the open/ close position for long periods of time. They shall be designed to operate satisfactorily even after being kept in one position for long period.

- C1313.3.6 The isolator shall be capable of breaking the magnetising current of associated power transformer.
- C1313.3.7 The temperature rise of any part of the isolator and associated equipment shall not exceed the maximum permissible temperature rise values.
- C1313.4 Contacts
- C1313.4.1 The main blades of all switches shall have adequate strength and current carrying capacity conforming to the maximum rating. The switch blade shall be so assembled that no part of the blade can move relative to other. The current path shall not be through any springs or movable pin connection. The contact shall be designed to be adjustable, self-aligning high pressure providing self-cleaning action. All contact surfaces shall be silver faced copper. All contacts shall be replaceable at site.
- C1313.5 Earth Switch
- C1313.5.1 Earth switch shall be provided wherever necessary and shall form an integral part of each pole of the isolator. The earth switches shall be three pole, manually group operated. Each earth switch shall be mechanically interlocked with its own blades when the main blades are closed and vice versa. A flexible tinned copper earthing braid of 185 sq.mm shall be provided from each earthing blade and shall be suitably attached to the earthing connector for common wire connection.
- C1313.6 Insulators
- C1313.6.1 The insulators shall be porcelain post type. Porcelain used for the manufacture of insulators shall be homogeneous, free from flaws or imperfections that might affect the mechanical or dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be of uniform brown colour, free from blisters, burns and other defects.
- C1313.6.2 The insulators shall have creepage distance to suit heavily polluted atmosphere. The porcelain and metal parts shall be assembled in such a manner that any thermal expansion differences between the metal and the porcelain parts throughout the range of temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high grade cast steel or malleable steel casting and they shall be machine faced smoothly and galvanised.
- C1313.7 Operating System
- C1313.7.1 Isolator shall be of manual closing type. The switch operating mechanism shall be so designed that it will not cause excessive deflection to the member to which it is attached. All switches shall be self-locking in the open and closed positions independent of the control shaft restraint. Each mechanism shall be provided with an indicator showing direction of rotation for opening / closing.
- C1313.7.2 The operating mechanism shall provide a quick, simple and effective operation. One man shall be able to operate the isolator / earthing switch without undue effort.

- C1313.7.3 The ganging mechanism shall be provided with sufficient adjustment to allow for final alignment of the isolator blades for simultaneous operation.
- C1313.7.4 The manual operating handles shall be mounted on the base of supporting structure. Guide bearings shall be provided if necessary at a height of 750 mm above grade level. All bearings shall be weather protected by means of covers and grease retainers. Bearing pressure shall be kept low to ensure long life and ease of operating.
- C1313.7.5 The operating mechanism to be with turn and twist arrangement.
- C1313.8 Interlock
- C1313.8.1 A mechanised key interlock shall be incorporated for interlocking with associated circuit breaker. The key shall be released only when the isolator is fully closed or fully opened.

C1314 ACCESSORIES

- C1314.1 Position Indicator
- C1314.1.1 A mechanical position indicating device shall be provided for each isolator / earthing switch.
- C1314.2 Terminal Pads
- C1314.2.1 Each isolator shall be provided with suitable terminal pads of high conductivity aluminium alloy. The terminal pads shall be designed to withstand loads due to dead weight of the aluminium tube / ACSR conductor connected to it and alignment of the isolator main blade shall not be disturbed due to the above.
- C1314.3 Earthing Pads
- C1314.3.1 Each pole of the isolator shall be provided with two earthing pads of non-corrodible materials at opposite ends, brazed to the base. Flexible tinned copper braid of 185 sq.mm shall be provided for connecting operating handles of isolators and earthing switches to the earthing system.
- C1314.4 Auxiliary Switches
- C1314.4.1 Each isolator switch shall be provided with a mechanically driven auxiliary switch with all necessary contacts for control, indication and interlocking purposes and with four normally open and four normally closed spare contacts. All contacts shall be rated for 10 amps. continuous rating at specified DC voltage.
- C1314.5 Name Plate
- C1314.5.1 A weather proof and corrosion proof name plate shall be provided on isolator, marked with information as per IS.
- C1314.6 Spares
- C1314.6.1 The Supplier shall furnish detailed list of spares as per his recommendations.

C1315 TESTS

- C1315.1 Factory Tests

- C1315.1.1 Complete tests shall be made at the manufacturers plant to determine the performance and operating characteristics of the assembled isolators, earth switches and their respective accessories to determine whether or not the guarantees have been met.
- C1315.1.2 Unless otherwise specified all tests shall be carried out in accordance with IS:9921. All routine and acceptance tests shall be witnessed by the Employer on free of cost.
- C1315.1.3 Specification for Earthing and Lightning Protection -Switchyard
- C1315.2 Introduction
- C1315.2.1 This specification covers the minimum requirements of the Earthing and Lightning protection for transformer bays added in 110 / 11 kV Substation.
- C1315.3 Standards
- IS:2309 - Practice for the protection of buildings and allied structures against lightning - code of practice
 - IS:3043 - Code of practice for earthing
 - ANSI/IEEE:80 - Guide for safety in alternative current substation grounding Indian Electricity Rules
- C1315.4 General Requirements
- C1315.4.1 The substation shall be provided with a complete earthing system, comprising earth electrodes in conduction with buried earth grid. The Vendor shall submit the design calculations.
- Fault level to be considered for sizing earth mat:
- C1315.4.2 As given in the specification for basis of design.
- C1315.4.3 However, the Vendor shall also get exact fault levels projected over 20 years from the Electricity Board.
- C1315.4.4 The effective earthing resistance shall not exceed 1 Ohm.
- C1315.4.5 After the award of the contract, the Vendor shall measure the resistivity at his cost and based on this, earthing system shall be designed. The soil treatment with salt charcoal etc. shall be done, if necessary, to bring down the soil resistivity to less than 60 Ohm- m.
- C1315.4.6 All buried conductors shall be of GI with earthing electrodes of cast iron pipe / plate.

- C1315.5 Design Basis for Earthing
- Time duration for conductor sizing : 3 Sec.
 - Time duration for calculation of step and touch : 1 sec. potential
 - Maximum allowable temperature for joints : As per IEEE-80
- C1315.6 Earthing Layout
- C1315.6.1 Earthing Conductors in outdoor areas shall be buried at least 600 mm below finished grade level unless stated otherwise.
- C1315.6.2 Minimum spacing between rodelectrodes shall be provided unless stipulated otherwise.
- C1315.6.3 Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, etc., it shall be laid minimum 300 mm below and shall be rerouted in case it fouls with equipment / structure foundations.
- C1315.6.4 Tap-connections from the earthing grid to the equipment / structure to be earthed shall be terminated on the earthing terminals of the equipment and structures, if the equipment is available at the time of laying the cover of 'earth riser' with temporary wooden equipment foundation / pedestal for future connections to the equipment earthing terminals.
- C1315.6.5 Earthing conductors along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding / cleating at intervals of 750 mm. Earthing conductors along cable trenches shall be on the wall nearer to the equipment. Cable trays and supports shall be connected to the earth mat at every 10 metres interval. Wherever it passes through walls, floors, etc. galvanised iron sleeves shall be provided for the passage of the conductor.
- C1315.6.6 Earthing conductor around the building shall be buried in earth at a minimum distance of 150 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.
- C1315.7 Equipment and Structures Earthing
- C1315.7.1 Earthing pads shall be provided by the Supplier of the apparatus / equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by short and direct earthing lead free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with Purchaser.
- C1315.7.2 Whether specifically shown in drawings or not, steel / RCC columns metallic stairs etc. shall be connected to the nearby earthing grid conductors by two earthinglead. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.
- C1315.7.3 Metallic pipes, conduits, and cable tray sections for cables installations shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system. 2 separate earthing conductors from rail clamps to the shore side shall be drawn to the pit. The construction of earth pits

(Separate) earthing conductor, its termination etc also shall be in the scope of the contractor.

- C1315.7.4 Metallic conduits shall not be used as earth continuity conductor.
- C1315.7.5 Wherever earthing conductor crosses or runs along metallic structures such as water, conduits, pipe, etc. and steel reinforcement in concrete it shall be bonded to the same.
- C1315.7.6 Light poles, junction boxes on the poles, cable and boxes / glands lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not.
- C1315.7.7 Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end.
- C1315.7.8 Substation gates shall be connected to the gate rod by 65 sq.mm 600 mm long copper flexible braid and the gate post in turn shall be connected to the main mat. Alternative fence post shall be connected to main earthing conductor by separate earth conductor.
- C1315.8 Specific Requirement for Switchyard Earthing Systems
- C1315.8.1 Each earthing lead from the neutral of the transformers shall be directly connected to two electrodes treated earth pit which, in-turn, shall be connected to station earthing grid. All electrodes shall have cement concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints.
- C1315.8.2 Earthing terminal of each lightning arrestor, power transformer and lightning down conductors shall be directly connected to earth electrode which, in-turn, shall be connected to station earthing grid.
- C1315.9 Jointing
- C1315.9.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surface shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested shall be painted with anti-corrosive paint / compound.
- C1315.9.2 Connections between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded / brazed type. The welds should be treated with red lead and afterwards thickly coated with bitumen compound to prevent corrosion.
- C1315.9.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- C1315.9.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- C1315.9.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any lead on it. Artificial cooling shall not be allowed.

C1315.10 Control Room Earthing

C1315.10.1 An extension of earthing conductor from the station earthing shall be supplied and installed by the SUPPLIER. The SUPPLIER shall also supply and install all required earthing for control and relay panel, switchgears, local PBs, distributions boards, etc. The metallic cases of all instruments, relays control switches mounted on the cubicle and panels shall be connected to the cubicle for panel earth busbar.

C1315.11 Lightning Protection System

C1315.11.1 7/9 SWG GS Shield wire with necessary tension and PG clamps, crimping type lugs shall be used, as per statutory regulations. The shield wires / spikes shall protect busbars and substation equipment with angle of shield as per statutory regulations.

C1315.11.2 The Conductors of the lightning protection system shall not be connected with conductors of the safety earthing system above ground level.

C1315.11.3 Down conductors shall be supported by suitable clamps on the structures at 750 mm interval.

C1315.11.4 Connection between each down conductor and pipe electrodes shall be made via test joint located approximately 1500 mm above ground level.

C1315.11.5 Lightning conductors shall not pass through or run inside GI conduits.

C1315.11.6 All metallic structures within a vicinity of 2000 mm in air and 5000 mm below ground shall be bonded to the conductors of lightning protection system.

C1316 11KV PANEL BOARDS

C1316.1 Scope of work

C1316.1.1 This specification covers design, Engineering, manufacture, shop testing, inspection, painting, packing, supply, forwarding and delivery to site with all accessories, storage, installation, Testing and commissioning of the 11kV VCB Panel

C1316.2 Design Requirement & Standards

C1316.2.1 11kV VCB Circuit Breaker panel shall satisfy following specifications and standards:

- | | |
|---------------------|---|
| Type | - Indoor |
| Operating mechanism | - Motor charged Spring |
| Standards | - IEC62271-1 For high-voltage switchgear and control gear |
| | - IEC62271-100 for HV AC CB |
| | - IS 13118-1991 of HV AC CB |
| | - IEC60529 for Degree of protection of enclosure |
| | - IEC60255 for Measuring Relays and Protection Equipment. |

- IEC 60298 for AC metal enclosed switchgear and control gear
- IEC60044 for Instrument transformer
- IS 3156 for PT and IS 2705 for CT

C1316.2.2 Functional Requirement. The circuit breaker shall be designed for local/ remote tripping and closing by normal means. The control circuits shall be designed to operate on 110 Volts D.C.

C1316.3 Description

- Value
- Rated Voltage
- 11kV
- Rated frequency & Number of phases
- 50Hz & 3 Phase
- Rated current
- As required
- Rated short time current and its duration (kA/Sec)
- 26.3 kA for 3 sec
- One-minute power frequency withstand voltage (kVrms)
- 28 kVrms
- Impulse withstand voltage (kVp)
- 75 kVp

C1316.4 General

C1316.4.1 The equipment supplied must have been in commercial production at least 5 years prior to supply with an established historical data base for good performance. The components of assembled unit shall be approved by a testing laboratory acceptable to client/consultant.

C1316.5 Rating

C1316.5.1 All panels assembled to form a board shall be suitable for the nominal operation voltage of 11kV and maximum system voltage of 12kV with 50Hz frequency and breaking capacity of 26.3kA for 3sec.

C1316.6 Type

C1316.6.1 The HV panel Board shall be metal clad, indoor, floor mounting, free standing and bus bar extendable on both sides. The panel shall be indoor type with degree of protection for enclosure IP-4X.

C1316.7 Service Conditions

C1316.7.1 The reference ambient temperatures assumed for the purpose of this specification are as follows:

- C1316.8 Ambient Temperature
- (a) Maximum - 45 degree centigrade
 - (b) Minimum - 15 degree centigrade
 - (c) Average temp. measured over a period of one month - 35 degree centigrade
- C1316.9 Relative Humidity (Average Value)
- (a) for a period of 24hrs, does not exceed 95%
 - (b) for a period of one month, does not exceed 90%
 - (c) Relative humidity may be temporarily 100%.
- C1316.9.1 General Construction
- C1316.9.2 Separately earthed compartments shall be provided for circuit breakers, bus bars, relay & instruments, CT&PT and cable boxes, fully and effectively segregating these from one another so that fault in any one compartment do not cause damage to equipment(s) in other compartment(s).
- C1316.9.3 The housing shall be of bolted construction to ensure compact and rigid structure, presenting a neat and pleasing appearance and constructed from prime quality folded and riveted aluminium zinc coated steel sheet. The sheet steel used should not be less than 2mm thick. The panels shall be bolted together to form a continuous flush front switch gear suitable for front operation of board. Illumination lamp shall be provided in all the compartment of HT panel Boards.
- C1316.9.4 Each switching assembly equipped for a withdrawable main circuit breaker/bus PT shall be provided with an automatic metallic safety shutters to prevent access to live equipment when circuit breaker/bus PT is withdrawn from the panel. The shutter mechanism should have the following features.
- Open and close automatically by means of positive drive initiated by the movement of the breaker/bus PT carriage.
 - Automatically isolate the stationary main circuit contacts (line and load stabs) when the circuit breaker/bus PT is moved out of its connected position.
- C1316.10 General Design Aspects
- C1316.10.1 The HV panel board shall be designed such that the switchgear, instruments, relays, bus bars, control wiring etc. are arranged and mounted with due consideration for the followings:
- Facility for inspection, maintenance and repairs, testing terminals and terminal boards for ease of external connection.
 - Minimum vibrations preventing the risk of accidental short circuits and open circuits for power and control circuits.
 - Risk of accidental contact and danger to personnel due to live connections.
 - Mountings at approachable height

- Lifting lugs for lifting the entire shipping section without distortion of any part of any enclosure

C1316.11 Vacuum Circuit Breaker

C1316.11.1 Circuit breakers shall be withdrawable Vacuum type of floor rolling/cassette design. Wherever cassette design of CB is offered, two CB handling trolleys shall be provided with switchboard. The complete assembly of interrupters contact pressure springs and HV terminals (top and bottom) shall be type tested for compatibility of design.

C1316.12 General Arrangements

C1316.12.1 The circuit breaker panels shall be complete with the following:

- Racking in / racking out mechanism.
- Isolating plugs and sockets.
- Mechanical inter-locks and safety shutters.
- Mechanical ON/OFF indicator.
- Minimum of 4 NO & 4 NC Auxiliary contacts directly operated by the circuit breaker.
- Anti-condensation space heaters suitable for operation on 240V, 1ph. 50 Hz A.C. for each panel.
- Suitable tripping arrangement.
- Mechanical counters to assess the total number of operations of the breaker.

C1316.13 Type

C1316.13.1 The circuit breaker shall be of horizontal isolation; horizontal draw out pattern.

C1316.14 Breaker Truck

C1316.14.1 The breaker carriage shall be fabricated from steel, providing a sturdy vehicle for the circuit breaker and its operating and tripping mechanism. The carriage shall be mounted on wheels, moving on guides, designed to align correctly and allow easy movement of the circuit breaker and for removing the carriage for inspection and maintenance purposes. Vacuum interrupters shall be fully encapsulated, hermetically sealed and designed for minimum contact erosion, fast recovery of dielectric strength, maintenance free and suitable for auto-reclosing. The drive mechanism shall preferably be provided with facility for pad locking at any position namely, "Service", "Test" and "Fully Isolated". It should be possible for testing the circuit breaker for its operation without energizing the power circuit in the "Testing" position. The contacts shall be made only after the breaker is inserted into service position. Interlocking should prevent contacts from being disconnected if circuit breaker is tried to be moved from service position.

C1316.14.2 Electrically operated auxiliary switches shall be provided as required for the control and indicating purposes. Each circuit breaker shall have a mechanical 'open/closed' indicator.

C1316.15 General Features

C1316.15.1 Single break contacts in sealed vacuum interrupter. Vacuum interrupter shall be fully encapsulated.

C1316.16 Rating

C1316.16.1 The circuit breakers shall be rated for normal operating voltage of 11kV, short circuit current of 26.3 kA for 3 seconds minimum.

C1316.17 Operating Mechanism

C1316.17.1 The operating mechanism shall be following as specified:

C1316.17.2 Motor operated spring charged with manual spring charging facility both mechanical and electrical release for closing. The operating mechanism shall be trip free. Closing mechanism shall be spring assisted electrically operated (with a spring charger having spring charge indication). The spring charging motor should be of totally enclosed construction. Built in manual charging handle should be provided with every circuit breaker for manual spring charging.

C1316.17.3 External auxiliary supply shall be made available for charging motors & heaters operation.

C1316.17.4 The following safety arrangements shall be provided for the safety of the personal and to prevent mal operation.

- Inter-lock to prevent the circuit breaker from being racking in and racking out when closed.
- Interlocking which prevents manual or electrical closing of the circuit breaker in the intermediate positions between connected or isolated.
- Inter-lock to prevent earth connection from being made by the earthing device except than the circuit breaker is open.
- Inter-lock to prevent the breaker from being made alive without its carriage in position.
- The breaker should have test positions to facilitate testing of control circuit.
- Automatic dust-proof safety shutter assembly should be provided for shrouding of live terminals while the breaker is drawn out.

C1316.18 Bus Bar Compartment

C1316.18.1 General Requirement: The switch board shall be single bus bar pattern with air insulated extensible type. Main bus bar shall have same cross section and rating throughout the switch gear. The bus bars shall be sleeved for full voltage. The joints shall be shrouded by epoxy material. Sleeve shall be heat shrinkable BTPM type of Raychem/equivalent make. The bus shall be supported by heavy duty high dielectric strength, non-hygroscopic insulating material. The rated strength of supporting insulators in their most probable mode of failures shall not be less than 2.4 times the working stress. Bus bar insulators designed shall be designed as per relevant IEC & to withstand dynamic stress developed under 500 MVA fault for 3 sec (minimum). Contractor shall submit required type & routine test certificates as per relevant IS/IEC codes. The bus system is also

required to withstand the specified impulse voltage level without the use of filled compounds, hand wound tapes etc. Bus bars shall be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.

- C1316.18.2 Bus bars shall be constructed from hard drawn, high conductivity, extruded Aluminium alloy of 1.0 Amps/mm² current density, rated for 26.3 kA for 3 seconds (minimum). Solid bars shall make connections to the main bus bars.
- C1316.18.3 The frame and all other metallic non-current carrying parts of the switch gear shall be bonded together and earthed through the external connection to a thorough going earth bar along the switchgear. There shall be terminals for connection to the external station earth bar at the bottom of each cubicle.
- C1316.18.4 Adequate clearance between 11kV point and earth and between phases shall be provided to ensure safety as per provision in CEA regulations and its amendment thereof and also in accordance with the relevant Indian standard specification. The same shall be capable of withstanding the specified high voltage tests as per ISS-13118/IES-60056 and its amendments thereof.
- C1316.19 Current Transformer
- C1316.19.1 General Requirements: Accommodation shall be provided in the circuit breaker panel to mount required set of single/dual core CTs for metering and protection purposes
- C1316.19.2 Rating: Dual core CTs of suitable burden (but not less than 15 VA) shall be with 5 Amps secondary. The CT ratios shall be chosen as per the feeder details.
- C1316.19.3 All CT's shall be of cast-resin type and shall conform to relevant Indian Standards. The design and construction shall be robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5 P10 conforming to IS 2705- Part III-1992.
- C1316.19.4 The mechanical and thermal current rating of CTs shall be coordinated with the momentary and short circuit current of the associated circuit breaker respectively. CTs used for differential scheme shall not be used for other relaying or metering circuits. All CTs used in differential protection shall have same ratio, compatible excitation and saturation characteristics and shall conform to relay manufacturer's requirements. External connection from CT secondary shall be wired to short circuiting type terminal boards. The metering CTs shall conform to the metering ratio and accuracy class Where ever it is not mentioned the accuracy class shall be 0.5 as per IS 2705.
- C1316.19.5 All current transformers shall have clear indelible polarity markings. The minimum class of insulation shall be "Class B".
- C1316.20 Voltage Transformer
- C1316.20.1 General Requirements: A voltage transformer of burden and of proper ratio as required. The accuracy class of VT shall be class 0.5 as per IS 3156 parts I to III for incomer and outgoing Panels. The basic impulse level (BIL) of the VT shall be same as that of switch gear. External connection to the VT secondary shall be through a test block.

C1316.20.2 The voltage transformer shall be of cast-resin single phase construction with fast acting primary fuse. VT shall be draw out type. Primary fuses shall be mounted on the withdrawable portion. Replacement of the primary fuses shall be possible with VT truck in 'ISOLATED' position. The secondary fuses shall be mounted on the fixed portion and the fuse replacement shall be possible without drawing out the VT truck from Service position. VT's mounted on circuit breaker truck shall not be accepted. Bus PT shall be 3 numbers of 1ph cast resin, draw out type with rating as per single line drawing, control MCBs, RYB indicators, Voltmeters, distribution connectors etc.

C1316.20.3 Rated voltage factor of 1.2 shall be considered for all VTs. All voltage transformers shall have clear indelible polarity markings. The minimum class of insulation shall be "Class B".

C1316.21 Protection and Tripping Arrangement

C1316.21.1 All the Relays shall be numerical, communicable design, flush mounting type, suitable for RS 485 communication port and IEC 61850 compatible. The minimum protection provided by these relay shall be over current, earth fault, short-circuit, under voltage and overvoltage protections. Tripping relay shall be used for tripping signal to the Shunt Trip Coil of Circuit Breaker operating on 110V DC.

C1316.22 Three Phase Numeric Overcurrent and Earthfault Relay

C1316.22.1 This specification covers for feeder protection relays used at 11kV, the relay should have four measuring elements

C1316.23 Technical Specifications

Rated current	- 5 A
Rated frequency	- 50 Hz
Auxiliary power supply	- 110v dc +/- 15%
Relay settings:	
Overcurrent	- 0.2 to 2 In in steps of 0.05 In
High set Overcurrent	- 0.1 to 40 In in steps of 0.2 In
Earth fault	- 0.05 to 0.8 times In in steps of 0.05
High set Earth fault	- 0.1 to 20 In in steps of 0.1 In
Time multiplier	- 0.1 to 1.6 in steps of 0.05 with independent settings for overcurrent and earth fault
Time/current characteristic	- Normal inverse, very inverse, extremely inverse and definite time
Serial Communication	- Compactible for IEC 61850

C1316.24 Control Wiring

C1316.24.1 The control wiring shall be carried out with minimum 1.5sq.mm HFFR insulated copper wire. CT wiring shall be done with minimum 2.5 sq.mm HFFR insulated copper wire and with colour code: RYB, Grey for auxiliary DC circuits and Black for auxiliary AC circuits. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Ferrules shall be fitted to all wire terminals to render identification easy and to facilitate checking.

C1316.25 Metering Instruments, Panel Accessories

C1316.25.1 The instrument panel shall form part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the tenderer. They shall be of flush mounting type.

C1316.25.2 Intelligent multifunction panel meter shall be with LCD display, TRUE RMS measurement, VT, CT ratio programmable at site, and having communication facility (RS 485 port) and capable of measuring V, A, kW, phase voltages and currents, phase kW, kWh, kVAr, kVA, Power factor, Frequency, Voltage and current harmonics.

C1316.25.3 Voltmeter of 96 x 96 mm size MI type (0-15) kV with selector switch.

C1316.25.4 Ammeter of 96 x 96 mm size MI type with selector switch

C1316.26 External Cabling

C1316.26.1 **Cable Entry:** Provision shall be made for connection of all power cables including proper terminal connectors or lugs, clamps, or terminations. In case an extension box is required to meet the vertical space requirement, the extension box shall be a part of the switch gear supply. 3 mm thick removable gland plate shall be provided for cable termination.

C1316.26.2 **Earthing:** The earthing of the breaker body and moving portion shall be so arranged that the earthing of the non-current carrying structure to the frame earth bar is completed well before the main circuit breaker plugs enter the fixed house sockets.

C1316.26.3 The entire panel board shall have a common tinned copper earth bar of suitable section with 2 earth terminals for effectively earthing metallic portion of the panels. The frame earthing of panel shall be in accordance with Earthing Section of this specifications.

C1316.27 Earthing Truck

C1316.27.1 One number Earthing truck suitable for all VCBs shall be supplied for each substation.

C1317 PAINTING AND GALVANIZING

C1317.1 Painting

C1317.1.1 All paints shall be applied on clean, dry surfaces under suitable atmospheric and other conditions in accordance with the paint manufacturer's instructions. All paints used shall be compatible with each other and capable of performance for five years in the environment specified without any need for maintenance. The minimum standards acceptable are:

- C1317.1.2 Cleaning by shot blasting to grade as 2.5 of ISO 8501-1.
- C1317.1.3 All sheet steel surfaces shall be degreased, pickled and phosphated in accordance with IS 6005- "Code of practice for phosphating of iron and steel.
- C1317.1.4 Immediately following phosphating, the surfaces shall be painted with two coats of high-quality zinc chromium primer.
- C1317.1.5 All rough surfaces of coatings shall be filled with approved two pack filler and rubbed down to a smooth finish.
- C1317.1.6 Interior surfaces of terminal boxes, after preparation, cleaning and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based undercoating, followed by a final coat of phenolic based finishing paint to white colour followed by a final coat of anti-condensation white paint of a type and make to the approval of the project manager. A minimum overall paint film thickness of 150 microns shall be maintained throughout. The first coat of primer shall be applied on the same day, preferably within two hours of shot blasting.
- C1317.1.7 Exterior steel surfaces and metal work after preparation and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based under coating and two coats of micaceous iron oxide paint, then painted with a final coat of phenolic based hard glass finishing paint of the light grey shade no.631 of IS 5, to provide an overall minimum paint thickness of 200 microns.
- C1317.2 Galvanising
- C1317.2.1 All galvanizing shall be carried out by the hot dip process in accordance with specialization ISO 1460 or IS2629. However, high tensile steel nuts, bolts and spring washers shall be electro-galvanised to service condition four. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.
- C1317.2.2 Before pickling, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paint, varnish oil, welding slag and other foreign matter completely removed. All protuberances which would affect the life of galvanizing shall also be removed. The weight of zinc deposited shall be in accordance with BS 729 and shall not be less than 0.61 kg/m² with a minimum thickness of 86 microns for items of thickness more than 5 mm, 0.46 kg/m² (64 microns) for items of thickness between 2mm and 5mm and 0.33 kg/036 (47 microns) for items less than 2mm thick.
- C1317.2.3 Parts that shall not be galvanized are those whose shapes are such that the pickling solution cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced.
- C1317.2.4 Repair of galvanizing on site will generally not be permitted.
- C1317.2.5 The threads of all galvanized bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the project manager. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled.

- C1317.2.6 Partial immersion of the work shall not be permitted, and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.
- C1317.2.7 After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing.
- C1317.2.8 To avoid the formation of white rust, galvanized material shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- C1317.2.9 The galvanized steel shall be subjected to tests as per IS 2633 and BS 729.
- C1317.2.10 Factory Acceptance Tests (FAT):
- C1317.2.11 All the tests shall be conducted on the VCB Panel as per relevant standards amended up to date. Client /consultant shall have the right to inspect the progress of work, quality of materials used/ workmanship and to witness the Routine tests after completion of work at the premises of the manufacturer. The contractor shall give at least 15 days' advance information to Client /consultant about the manufacturing and Routine tests plan so that Client /consultant can witness the tests. The factory acceptance test shall at least include.
- High Voltage test of the bus bar system and circuit Breaker
 - Insulation Resistance Test
 - Safety Interlock checks
 - Functional Test
- C1317.3 Installation, Testing and Commissioning
- C1317.3.1 The HT switchboard shall be installed in dust and moisture free space. The depth of the trench below the HT switchboard shall minimum 1200mm for the safe bending and termination of the cables. The space round the panel shall be provided as per Indian electricity norms.
- C1317.3.2 The installation work shall cover assembly of panels lining up, grouting the units etc. In the case of multi panels switch boards, after connecting up the bus bar all joint shall be insulated as approved by the manufacturer. A common earth bar shall be run below the switch board connecting all the sections to the earth system. All protection, indications & metering connections and control wirings shall be completed in all respects.
- C1317.3.3 Trip supply battery shall be installed and commissioned, completing initial charging of the batteries. All relays and instruments shall be mounted and connected with appropriate wiring. Calibration checks of CTs, VTs Energy Meters etc. shall be completed before pre-commission checks are undertaken.
- C1317.3.4 The contractor shall conduct a short circuit study and prepare relay co-ordination chart before pre-commissioning tests and setting of relays. The same to be submitted for review and approval to the Employer. Procedure for testing and commissioning of relay shall be in general accordance with good practice.

- C1317.3.5 Commissioning checks and tests shall include in addition to checking of all control wiring connections, relays calibration and setting tests by secondary injection method and primary injection method. Primary injection test shall be done for operation of relay through CTs. Before panel board is commissioned, provision of the safety namely fires extinguishers, insulation mats and danger board shall be ensured.
- C1317.3.6 The site acceptance test (SAT) shall include following.
- Operation checks and lubrication of all moving parts.
 - Interlock function checks
 - Continuity checks of wiring, fuses etc. as required
 - Testing of individual breakers for integrity of vacuum bottle, measurement of contact resistance, opening and closing time of breaker contacts.
 - Testing of all protective and synchronizing equipment for proper operation.
 - Calibration of all measuring instruments.
 - Testing of all LV/HV cables
 - Testing of CTs and VTs for ratios and polarity.
 - Insulation tests.
 - Alarm, Trip and closing circuits.
 - The complete panel shall be tested with 5000V insulation tester for insulation between poles and poles to earth.
 - Insulation test of secondary of CTs and VT to earth shall be conducted using 500V insulation tester.
 - The entire switch board shall withstand high voltage test after installation.
 - Any other tests as required by the client/consultant shall be conducted.
- C1317.3.7 The Employer shall be allowed to witness tests free of charge.
- C1317.3.8 The Contractor shall arrange testing of relays, meters through State Electrical inspectorate relay testing wing. The testing equipment including primary and secondary injection sets etc. shall also have to be arranged by the Contractor. Testing and fee demand by the State Electrical Inspectorate shall be on contractor scope.

C1317.4 Data to be furnished by the Bidder/Manufacturer

S. No.	Description	Client Requirement	To be Filled by the Contractor
1	Switchgear Panel-General		
2	Manufacturer's name	As per approved makes	
3	Minimum temperature rise over ambient(0C)	AS PER IEC	
4	Interchangeability of similar equipment	YES	
5	Whether fully compartmentalized design or not	YES	
6	Applicable standard and degree of protection(IP)	IP 4X	
7	Type of installation (indoor/outdoor)	INDOOR	
8	Type of Material used for sheet steel	Powder coated MS sheet	
9	Whether each switchboard is extendable on either side	YES	
10	Bus bar		
11	Conductor material		
12	Bare/painted/ sleeves	Painted Conductor	
13	Rated short time current and its duration(kA/Sec)	26.3 kA for 3 sec	
14	Applicable standard	IS/IEC	
15	Vacuum Circuit breaker (VCB)		
16	Type	VCB with fully encapsulated vacuum interrupter	
17	Rated voltage and frequency(kV,Hz)	12kV , 50Hz	
18	Operating voltage and frequency(kV,Hz)	11kV , 50Hz	
19	Rated short time withstand current and its duration with breaker as housed in the	26.3 kA for 3 sec	

S. No.	Description	Client Requirement	To be Filled by the Contractor
	panel(kA/sec)		
20	Making current (peak)		
21	One minute power frequency withstand voltage(kVrms)	28 kV rms	
22	Impulse withstand voltage(kVp)	75 kVp	
23	Interchangeability of similar equipment	Yes	
24	Duty cycle	O-0.3sec -CO-3min-CO	
25	Whether horizontal draw out.	(Yes/No)	
26	Standard to which conforms	IS/IEC	
27	Whether anti-pumping device provided	YES	
28	Type of closing	Electrical & Mechanical	
29	Type of tripping	Electrical & Mechanical	
30	Normal voltage of :		
31	a) Closing/tripping mechanism		
	b) Spring charging motor		
	Allowable variation of voltage for the above	85-110%	
	Auxiliary contacts	4NO+4NC	
	Whether terminals suitable for XLPE 300sq.mm cable	Yes	
	Whether the vacuum bottles used in incoming and outgoing panels are same or different.	Same	

C1317.5 Spares for HT Panel

C1317.5.1 The following spares shall be supplied along with each panel without any additional cost.

1. MCB: 2 of each rating

2. MCCB: 1 of each rating
3. Indication lights: 5 of each colour
4. Ammeter: 1 of each rating
5. Voltmeter: 1 of each rating
6. Aux relay: 1 of each rating
7. Contractor: 1 of each rating
8. CT/PT: 1 of each rating
9. Multifunction meter: 1 number in each model

C1317.6 Taking Over

C1317.6.1 The Client shall take over the HT Panel Board for operation on completion of following.

1. HT Panel Board is installed, tested and commissioned as per specification
2. Training to at least one Employer and Two technicians shall be provided for operation & maintenance of HT Panel Board at Factory or Site.

C1317.6.2 Cast Resin Dry Type Distribution Transformer (Indoor):

C1317.7 Scope

C1317.7.1 This specification covers the technical requirements for design, manufacture, supply, Installation, Testing and commissioning of the dry type distribution transformer. Forced cooling to be provided for the higher rating dry type transformer.

C1317.8 Codes and Standards

C1317.8.1 The Transformers shall comply with the following Standards as amended up to date:

Title	Indian & IEC Standards
Dry type power transformers.	IS 11171: 1985
Installation and Maintenance of Transformers	IS10028 (Part II & III)
Current Transformers	IS 2705
Terminal marking connections	IS:2026 (Part IV)

C1317.9 General Requirements

C1317.9.1 All the MS parts shall be either Hot dipped galvanized or cold galvanized to make them corrosion free. The core shall be made up of high grade low loss cold rolled grain oriented laser scribed silicon steel. Both low & high voltage windings shall be made of copper conductor. The class of winding insulation shall correspond to class-F. The construction of the windings of the transformer shall be such that no creepage path is found even in dusty & corrosive ambient conditions. HV Phase terminals shall be brought out through resin cast terminals and connected to the bus bars provided in a separate chamber in HT Panel. LV terminals shall be brought out to LV Terminal Box. Protection against high winding temperature shall be provided by Thermistors. Winding temperature detectors with scanner for temperature ALARM and TRIP, door safety limit switches and accessories shall be provided.

C1317.10 Specification of cast resin dry type transformer

1	Rated power	:	
2	Frequency	:	50 Hz
3	Type	:	Indoor, copper winding and laser scribed core
4	Type of cooling	:	Air cooled
5	No. of phases	:	Three
6	Rated voltage	:	
	HV	:	11000 volts
	LV	:	
7	Vector group	:	DYN-11
8	Tap changer	:	OFF Load Operation
9	Tapings range	:	+10% to -10% in steps of 2.5%
10	Winding connection	:	
	HV	:	Delta
	LV	:	Star
11	Terminal arrangement	:	
	HV	:	Suitable for connecting HT cable
	LV	:	Suitable for connecting LT cable
12	Neutral terminals	:	Two, one brought out for earthing
13	Body earth terminals	:	Two

C1317.10.1 It shall be provided with channel iron welded to the bottom for easy and safe handling. Guaranteed iron losses, copper losses, regulation etc. shall be as per Technical particulars. Indoor transformers shall be suitable for IP-23 protection;

C1317.11 Service Condition

- C1317.11.1 The reference ambient temperatures assumed for the purpose of this specification are as follows:
- C1317.11.2 Ambient Temperature:45 degree centigrade
- C1317.11.3 Relative humidity may be temporarily 95%.
- C1317.12 Accessories
- C1317.12.1 **Tap Changing Device:** Preferred tapping range is +10% to -10% in steps of 2.5 by means of off load tap changing links or tap switch. The device shall be provided on HV winding.
- C1317.12.2 **Terminal Markings Connections:** Relevant provisions of IS: 2026 (Part-IV)-1977 shall be applicable.
- C1317.12.3 **Cooling:** The transformer shall be designed to give normal output with natural air cooling. Forced cooling shall be provided to take overload for emergency operation.
- C1317.12.4 **Fittings:** The transformer shall be complete with the following fittings:
- Off load type tap changing link or tap switch.
 - RTD / thermocouples with Indicator & relay shall be provided to monitor temperature of the winding and to start the cooling fans when the normal temperature limit exceeds and also to give alarm and shut down when temperature exceeds the limits even with forced cooling.
 - Lifting lugs.
 - Rating diagram and terminal marking plate.
 - Additional Neutral separately brought out on a bushing.
 - Earth terminals (2 Nos.) for body earthing.
 - Necessary hardware, clamps, lugs etc. for termination on HV/MV terminals.
 - All other standard fittings and accessories confirming to relevant IS standards
- C1317.12.5 **Rating Plates:** A rating plate of weather proof material bearing the data specified in clause-8 of IS: 11171: 1985
- C1317.13 Factory Acceptance Tests
- C1317.13.1 All routine tests and other tests prescribed in IS shall be carried out at the manufacturer's premises for the transformer in the presence of inspecting officer/Employer. Copies of the test certificates shall be furnished. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate done on the same type/design of the transformer shall be furnished in accordance with IS 11171: 1985 for purpose of records. If no impulse test was done in an earlier unit of the same design and type, one transformer will be subjected to impulse test in consultation with the Client/consultant at the firm's cost. Copies of the certificates of type test for short circuit shall be supplied to the Client/Consultant.
- C1317.14 Data to be furnished by the Bidder/Manufacturer

DISTRIBUTION TRANSFORMERS:		
S. No	Description	CLIENT REQUIREMENT
1	Rating	
2	Name of manufacturer	As per Approved Makes
3	Service	Indoor
4	Type	Dry -Resin Cast Core Coil Assembly
5	Winding Material	Copper
6	Core	Laser scribed Core
7	No Load Losses preferred (W)	As per ECBC Guidelines
8	Load Losses preferred (W)	As per ECBC Guidelines
9	Cooling	AN & Forced
10	Rated no load voltage	
11	a) HV, kV	11kV
12	b) LV, V	As required
13	Temp. rise above an ambient of 50 deg. C for Winding 90 deg. C	90 deg. C
14	Number of phases	3
15	Vector Group reference	Dyn11
16	Terminal arrangement, HV /LV	HV & LV termination shall be done with support insulators and suitable Cable/ Bus duct as per requirement
17	Taps on HV winding	
	a) Off circuit	Off circuit tap links
	b) Tapping range	+10% to -10%
	c) No. of steps	9 steps. In Steps of 2.5 %
18	Impedance with IS Tolerance	As per IS
19	Losses (kW) with IS Tolerance	As per IS
20	Transformer Compartment Enclosure protection class	IP-23
21	Class of Insulation winding	F

C1317.15 Installation, Testing and Commissioning at Site

C1317.15.1 All routine and other tests prescribed in IS 11171: 1985 shall be carried out for the transformer at site. Checks and test shall include following.

- Measurement of Voltage ratio, polarity and check of voltage vector relationship.
- Measurement of no-load and excitation current.
- Measurement of insulation resistance between HV winding and earth LV winding and earth, HV winding and LV winding.
- Measurement of polarization index (PI)

C1317.16 Spares for Transformer

C1317.16.1 The following spares shall be supplied along with each transformer without any additional cost.

1. Neutral CT: 1 of each rating
2. Winding Temperature Indicator/Relay :1 No.

C1318 BUS DUCT (SANDWICH TYPE)

C1318.1 Scope

C1318.1.1 This specification is intended for design, manufacture, transporting, installation and testing at site of compact sandwich type Aluminum/Copper conductor LT Bus Bar Trunking system (Bus duct) suitable for indoor/outdoor installations. Self-cooled, sandwich construction Al/Cu bus duct as per the specific requirements shall be supplied. The bus bar systems offered shall be complete with all necessary accessories like elbows, off sets, reducers etc.

C1318.2 Standards

C1318.2.1 LT Bus Bar Trunking system (Bus ducts) shall satisfy the requirements given below and shall also comply with standards in force when the bus ducts are manufactured, particularly which are in the following table. (Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable): -

C1318.2.2 IEC 61439- 6: Low-voltage switchgear and control gear assemblies - Part 6: Bus bar trunking systems (busways)

C1318.2.3 IEC 61439- 1: Low-voltage switchgear and control gear assemblies - Part 1: General rules

C1318.2.4 IEC 60529: Degrees of protection provided by enclosures (IP Code)

C1318.3 Technical Requirements

C1318.3.1 For Aluminium Bus duct, Bus bar shall be fabricated from aluminium and the conductors shall be continuously nickel/ tinned / copper / suitably plated for the entire length. For Copper Bus duct, the bus bars shall be of high conductivity copper of 99.9% pure grade and shall be continuously nickel/ tinned / copper / suitably plated for the entire length. Rating of busbar shall be as per data sheet, and it shall be 3Phase +100% Neutral+ 50% integral earth including bends.

- C1318.3.2 Bus bar conductors shall be insulated with single/multilayer of insulation of class
- C1318.3.3 F. Electric connection shall be made at joints by single/multi bolt joint construction which ever suited. Joints shall be realized by a torque spanner (wrench) and shall be set as per the manufacturer design. To prevent the joints to be damaged during transport, they shall be protected by plastic caps, which shall be removed before installation. Standard or designed locking system shall be put in place to prevent loosening of any screw and requiring any tightening schedule during maintenance. The design should have a provision to identify unraveling of the screw/nut by a degree and a marker to indicate, if the bolt has shifted from net position.
- C1318.3.4 Each bus bar shall be jointed to the adjacent section by single/multi bolt-joint clamps without drilling the bus bar. Joint between two sections shall be such that a complete sub assembly is removable so that isolation of individual sections is possible without disturbing other sections.
- C1318.3.5 Inspection windows shall be provided over the joints to check tightness.
- C1318.3.6 The enclosures of Bus ducts shall be totally enclosed non ventilated type. Ingress protection for the enclosures shall be IP 54 for indoor Bus duct and IP 65 for outdoor Bus duct as per IEC 60529.
- C1318.3.7 The enclosure of Bus Trunking System shall be fabricated from 1.6 mm thick CRCA sheet steel/ GI/ extruded Al and shall be powder coated to colour shade RAL 7032 after regress metal treatment process.
- C1318.3.8 Enclosure shall be rendered dust proof and vermin proof by adequate gasketing etc. to provide ingress protection of not less than IP 54 for indoor Bus duct and IP 65 for outdoor Bus duct as per IEC 60529. The gasket material shall be suitable for more than the class of insulation. The Bus bar Trunking System shall be manufactured in convenient section to facilitate easy transportation and installation. The sections shall be connectable to form vertical or horizontal runs as required. Each section shall be provided with suitable support arrangement from walls / ceilings as required. Expansion joints may be provided as per manufacturer's design and recommendation.
- C1318.3.9 Flanged End Box: Flanged end box shall be provided to accommodate flange end for connecting the bus trunking with the flanges of panels, transformers and DG Sets etc. through flexible connections. Phase matching of bus trunking with equipment shall be done prior to installation.
- C1318.3.10 Expansion Joints: The bus bar system shall be equipped with standard expansion joints or with expansion bolts in each unit length to compensate thermal elongation of the bus bar. As far local conditions permit, the longest bus bar unit lengths shall be used to minimize electrical losses at the butt or bolted connections of the bus bars. The bus bar junction points shall be suitably marked for identification.
- C1318.3.11 Flexible connections shall be provided by braided or multi leafed conductors for termination
- C1318.4 Additional Requirements

- C1318.4.1 **Tap Off Provision:** Rising Mains shall have provision to install the tap off boxes at minimum 3 locations in standard length of 3 m. Plug in points shall have a hinged sheet metal that provides IP protection similar to specified for Bus duct. There shall be provision for up to 3 plug in tap off boxes. Rating of plug in tap off boxes shall start from 100 ampere and shall be up to and including 400 ampere. Plug in tap off boxes shall have an electrical interlock mechanism which also insures that plug in tap off box cannot be removed mechanically from the bus bar when the box is at ON position. Tap off boxes shall be suitable for any brand of MCCB. Tap off boxes shall be manufactured of similar material and color as main bus duct. Tap off boxes shall be plug in type with earth contact to make first and break last. Tap off boxes shall have spring loaded contacts for uniform contact pressure on bus bars. Tap off boxes shall be provided with door interlocking and interlocking with bus trunking to ensure plug in and plug out possible only in OFF condition. All tap off boxes shall be compatible with all rating of bus trunking and shall be suitable for interchanging between sandwich/air insulated trunking. Tap off outlets shall be available as required by the system design. Tap off outlets shall have safety shutters to prevent access to live bus bars when not in use. Degree of protection in the open conditions with shrouding shall be IP 2X to offer personal safety protection.
- C1318.4.2 **Thrust Pads:** Thrust Pads shall be provided in the raising main systems for necessary support to the rising mains and to prevent bus bar expansion in down ward direction.
- C1318.4.3 **Accessories:** Bus trunking system shall be complete with all accessories like bends, Ts, vertical anchors, expansion joints, flexible connections etc. to suit site requirements. Bus trunking systems shall be complete in all respects. All accessories shall be deemed to be included in the straight length of the bus duct and rising mains.
- C1318.4.4 **Terminal arrangement:** Suitable arrangements shall be available for cable terminations so that the cable weight doesn't come on the terminals. The terminal on HV & LV shall be suitable for receiving copper flexible cable as specified in 3.1.5 and termination with cable gland and anodized hard wire for the cable termination.
- C1318.4.5 **Safety Factor:** The contractor will submit the Bus duct support calculation incorporating safety factor not less than or equal to 3 and dead weight of the bus duct along with hanging arrangement detail.
- C1318.4.6 **Grounding:** Bus trunking system shall be provided with two independent earthing GI conductors size of at least 50x6 (mm)/ as suitable throughout the length of the system. The earth flats shall be effectively connected to the enclosure by riveting/bolting. End covers shall be provided as required. Neutral shall have same cross section as phases. All parts of the bus enclosure, supporting structures and equipment frames shall be bonded to the ground bus.
- C1318.4.7 **Type test:** LT Bus Bar Trunking system (Bus duct) offered shall comply to verification and Type test requirements of IEC 61439-6. Type testing shall be conducted from accredited Lab. Copies of the test certificates for same rating shall be submitted at the time of vendor approval. These shall not be more than 5 years old.

C1318.4.8 Routine & Acceptance Test: Testing at manufacturers' works shall be conducted before dispatch as per Routine verification requirements as per IEC 61439-6.

C1318.5 Test at Site

- Physical check including checking damage/crack in any components, tightness of bolts and connections etc.
- Insulation test after installation according to manufacturer's test procedures
- Testing earth continuity

C1318.6 Installation of Bus Duct

- Installation of the Bus Duct shall be carried out as per manufacturer's instructions and installation shall be verified by the manufacturer before energising.
- For Bus Duct horizontal runs, horizontal expansion units shall be provided at suitable intervals at least every 40 m and at expansion joints of the building structure and the system shall be supported at least every 1.5 m.
- Annular space around or Bus Ducts while crossing walls shall be filled up by sealing material by contractor in accordance with the manufacturer's instructions.

C1319 FREQUENCY CONVERTER

C1319.1 Scope

C1319.1.1 This specification covers the technical requirements for design, manufacture, supply, Installation, Testing and commissioning of the Frequency converter and related accessories and control panel.

C1319.2 General Requirements

C1319.2.1 Some of the naval vessel need power supply at 60 c/s. But the available power supply at shore is 50c/s. Hence the frequency needs to be converted from 50Hz to 60Hz to feed shore supply for few of the naval vessel.

C1319.2.2 Frequency converter rating is specified in the Single line diagram. However, the contractor shall recheck the rating as per the load requirement of the vessel at 60Hz. If there is any change in the rating the same to be communicated to the Employer.

C1319.2.3 Static frequency converter have been considered in the preliminary design of the power distribution system as per the vessel requirement.

C1319.2.4 Static frequency convertors rating is 440V,1500 KVA, 50Hz to 60Hz and 3 Nos are required for the project.

C1319.2.5 Frequency converter shall be designed based on the Indian and international standard.

C1319.2.6 The frequency converters shall be a standard product of the manufacturer and shall be the manufacturer's latest design that complies with the specification

requirements. Monitoring and Control Panel also to be provided along with the frequency converter. The frequency converter shall be supplied with commissioning spares as per manufacturers recommendation.

C1319.2.7 Frequency Stability: 60 Hz within plus or minus 2 percent for all operating conditions, including maximum and minimum specified input voltages, ambient temperature and relative humidity. The frequency regulation shall be independent of load changes. The following documents to be Furnished with Equipment

- Factory Test Report
- Protective Packaging
- Installation Drawings
- O&M Manual
- Warranty Statement

C1320 LT PANEL BOARDS & ACCESSORIES

C1320.1 Scope

C1320.1.1 This specification covers design, manufacture, supply, Installation, testing and commissioning of L.T. Panel Board.

C1320.2 General

C1320.2.1 This Section covers the detailed requirements of low voltage switch gear Panel for 440V or 415V or 380V, 3 phase 50Hz/60 Hz, 4 wire system. All switchgears shall be fully rated at an ambient temperature of 45°C. All the switch boards are to be factory assembled, fabricated by a firm having CPRI / NABL type test certificate for short circuit rating, temperature rise and IP classification for similar panels. These type test certificates shall be submitted to the Employer for verification. The LT Panels shall be suitable for connectivity of SCADA and BMS interfaces. There shall be space provision for CO2 flooding fire trace tube system inside the panel. Sufficient potential free contacts (minimum of 8nos) shall be provided in Main LT panels for future interfacing with other systems. Illumination lamp shall be provided for all floor mounted Panels.

C1320.2.2 Minimum 2 or 20% spare feeder to be provided for each panel Board.

C1320.2.3 In LT metering for Commercial purpose, energy meters shall be tested from NABL accredited lab or Kerala state Electrical Inspectorate.

C1320.3 Switch Board Construction

C1320.3.1 The switch boards are to be manufactured / assembled as per the latest BIS/IEC specifications, IP54 classification for indoor duty, IP65 with double door for outdoor duty, including special requirements of Kerala state Electrical Inspectorate and the detailed specifications mentioned. The panel shall be floor mounted, free standing type, suitable for indoor installation in dust, vermin proof construction and extensible type. The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IS: 8623/1993 for factory assembled switch board, form 4B construction.

- C1320.4 Housing Details
- C1320.4.1 The Switch Board shall be fabricated out of 14 SWG (2mm) CRCA sheet for frame and 1.5mm for door and internal partitions (except load bearing members). It shall be provided with hinged doors on the front with necessary handles and earthed using flexible copper conductor. The doors shall be provided with neoprene gaskets. Suitable channel base frame should be provided for the panel board.
- C1320.4.2 Detachable gland plates of 3mm thick shall be provided at the bottom and top of the cable chamber, suitable for the termination of cables with double compression type glands to the sizes as specified. Adequate space should be provided in the cable chamber for safe bending and termination of runs of cables and size as required.
- C1320.4.3 The enclosure shall be provided with lifting hooks, supporting legs and double earth terminals with double washers.
- C1320.4.4 The switch board shall be in cubicle design (Form 4B) and fully compartmentalized having total segregation between each cubicle. Suitable cable and bus bar alleys shall be provided. All components of the switch board shall be approachable from front. The Bus bar chamber cover should be bolted type. The maximum operating handle/push button height of any feeder shall not be more than 1800 mm with reference to panel bottom. Supporting arrangement for dressing of power and control cables in cable alleys also shall be provided. The front openable/lockable door shall act as a cover for the switch boards. When door is open no live parts are accessible from the front door open case.
- C1320.4.5 The bus bar should be extendable at both ends. No bus bar should protrude in the cable alley. General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Overall height of the panel shall not exceed 2.1 meters. Multi-tier mounting of feeder is permissible. The general arrangement for multitier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look.
- C1320.4.6 The general arrangement and design of panels shall be got approved by client/consultant before fabrication. Cable entries for various feeders shall be either from top or bottom. Through cable alleys located in between two circuit sections, either in the rear or in the front of the panel. All cable terminations shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when new feeders are added. Cable entry plates shall therefore be sectionalized. The construction shall include necessary cable supports for clamping the cable in the cable alley or rear cable chamber.
- C1320.4.7 Cubicle panels with more than 1000 Amps Bus bar shall be made of suitable structural modular sections.
- C1320.5 Powder coating

- C1320.5.1 All metal sheets shall undergo 7 tank metal treatment thorough degreasing, water rinse, de-rusting, water rinse, phosphating, water rinse and then passivation.
- C1320.5.2 All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dirt. Fabricated structures shall be pickled and treated to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking powder coating.
- C1320.5.3 The colour of the Panel shall be colour of paint light grey to shade RAL 7035, however the contractor shall obtain details of approved colour from the Employer before powder coating. Panel finish shall be free from imperfections like pin holes, orange peels, run-off paint, etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust, corrosion, etc.
- C1320.6 Bus bar sizing, connection and supports
- C1320.6.1 The bus bars shall be made from high conductivity electrolytic grade Aluminium conforming to IS 5082. The bus bars and supports shall be capable of withstanding the rated and short circuit current as per the single line diagram/ feeder details. Minimum size of main power bus bars shall be of incomer switch rating and interconnecting bus bar to feeders should be rated to switch rating. The neutral and phase bus bars shall have the same rating.
- C1320.6.2 Maximum current density permissible for Aluminium bus bars shall be 1.0 Amps/Sq.mm without considering de-rating factors. An earthing bus bar of copper suitable for withstanding the fault current for 3 seconds or 150 sq.mm section copper whichever is higher shall be provided outside panel at bottom throughout the length of the panel.
- C1320.6.3 The bus bar system may comprise of a system of main horizontal bus bars and ancillary vertical bus bars run in bus bar alleys on either side of which the circuit could be arranged with front access cable entries. In the case of rear access, horizontal bus system shall run suitably either at the top or bottom. All connections to individual circuits from the bus bar shall preferably be solid connections.
- C1320.6.4 The bus bars shall be provided with heat shrinkable PVC insulating sleeve (FRLS). Supports for bus bars shall be made of suitable size cast resin insulators or SMC/DMC solid block type base and these should be adequate in number so as to avoid any sag in the bus bars. (Hilum supports may not be used). Minimum clearance between phase to phase shall be as per IS/IEC standards. The entire panel shall have a common earth bar of size as specified with two terminals for earth connections. For panels, Bus bars, risers and droppers and cable terminations including cable lugs bolts and nuts shall be fully insulated. This shall be achieved by applying heat shrinkable materials to the bus bar and shrouds at the bus bar joints and cable terminations. All insulation materials shall be FRLS PVC.
- C1320.7 Power Connection

- C1320.7.1 For power interconnections within the panel board rigid Aluminium conductor, with PVC insulation, of adequate cross section i.e., current carrying capacity not less than the outgoing switches rating shall be used. Cable lugs/ sockets of suitable size and type shall be used for all interconnections.
- C1320.7.2 For incoming and outgoing feeders of the switch boards, Aluminium conductor cable will be used and hence the panel has to be designed for receiving these and wherever required cable boxes shall be provided in panel by removable gland plates and shall be provided on top/bottom of panel, for cable entries.
- C1320.7.3 In case of panel boards having bus duct as incomer, the panel board should be designed to accommodate proper connection/termination of the bus duct. Adequate cable termination facility shall be made in the panel boards to terminate required runs and size of cables.
- C1320.7.4 To prevent accidental contacts, all interconnecting cables/ bus bars and all terminals also shall be shrouded. Provision for clamping the cables inside the cable alley should be provided.
- C1320.7.5 Standard colour code of red, yellow and blue for phases and black for Neutral to be followed for all bus bars/conductors.
- C1320.8 Auxiliary wiring and Terminals
- C1320.8.1 Wiring for all controls, protection, metering, signaling, etc. inside the switchboard shall be done with 650 volts' grey colour minimum 1.5sqmm HFFR (Halogen free fire retardant) copper conductor cables. Control wiring to components fixed on doors shall be flexible type. CT wiring shall be done with minimum 2.5 sq.mm copper wires with colour code.
- C1320.8.2 Wiring shall be suitably protected within switch board. Runs of wires shall be neatly bunched, suitably supported and clamped. All control wiring meant for external connections are to be brought out of terminal board.
- C1320.8.3 The complete panel would be sub-divided into different sections and each section shall have its own control circuit with fuse and indication.
- C1320.8.4 All control wiring should be provided with necessary cable sockets/ lugs at both ends. Conductors shall be terminated using compression type lugs. Each termination shall be identified at both the ends by PVC ferrules.
- C1320.8.5 The identification termination numbers should match with those on the drawings.
- C1320.8.6 Minimum 8 numbers of potential free contacts shall be provided in Main HT /LT panels for future interfacing with other systems.
- C1320.9 Component of switch boards
- C1320.9.1 The panel shall be provided with ACB, MCCBs, SDFUs, fuses, meters, relays and instruments, PLC etc. of size, capacity as specified in specification, schematic drawing and design calculation. The switch gears should be positioned inside the panel board as per manufacturers' standards.

C1320.10 Air Circuit Breaker (ACB)

C1320.10.1 The ACB shall be Microprocessor based, quick make, quick break, trip free horizontal draw out type electrically operated, provided with shunt releases. The cradle used for movement of draw out type ACB shall be suitable for smooth withdrawal on steel balls or rollers. ACB should be suitable for remote communication capability and protection with microprocessors. The Breaker shall be suitable for line load reversibility, without any deration. The ACB shall conform to IS 13947-1&2 /IEC60947-1&2 for circuit breakers & shall be suitable for Isolation as per IEC. The breaker shall offer double insulation on the front face (Class II deg. of operating safety). Contact wear erosion indicator should be available in the ACB for maintenance schedule.

C1320.10.2 The microprocessor based trip units should be of withstanding high ambient temperatures, switching surges, electromagnetic interferences, vibrations and switching arcs. The trip units should be of self-powered by the built in CTs or capable of operation with auxiliary power supply (230 V AC). Indication system should be provided for the functionality of the trip unit system and microprocessor fault. The trip units should have LCD display. The CT operated release should provide accurate and versatile protection, viz. Over load, short circuit and earth fault/LSIG protection. The breaker shall comply with service, test, isolation and maintenance position setting with locking facility in any position. Test socket shall be provided to check through test kit the microprocessor trip unit operations/actual trip time on the protections. The release shall have push to reset button for anti-pumping function.

C1320.10.3 The microprocessor release shall have IDMTL curve for co-ordination of overload curve with HT switchgear.

C1320.11 Communication

C1320.11.1 The communication port shall be used to read and set the parameters for the protection function. It should be able to transmit the causes of tripping and alarms. It should be possible to access the trip history and maintenance indications.

C1320.12 Protection

Overload protection in phase: 0.4 to $1I_n$ in steps 0.05 with time delay from 0.5seconds to 30 seconds minimum in stages.

Overload protection in neutral: 0.5to $2I_n$ in steps 0.05 with time delay from 0.5seconds to 30 seconds minimum in stages.

Short circuit protection: 0.6 to $10I_n$ in steps of .05 with 20 to 400milli seconds minimum in different stages.

Instantaneous: 1.5 to $15I_n$ in steps of 1 with provision to enable or disable.

Earth fault: 0.2 to 0.6 in steps of 0 .1 minimum with 100msec to 400 milliseconds minimum in stages

C1320.13 Thermal Memory

C1320.13.1 Thermal memory shall be provided for overload with provision to disable. The breaker shall have in-built battery backup for minimum 12 hours. Trip devices require a thermal memory function suitable for resistance welding loads on appropriate Substation. Two spare "a" and "b" auxiliary contacts (3 NO+3 NC) for each circuit breaker wired to terminal block.

C1320.13.2 Shunt trip with 230 V AC, rated coil for remote tripping.

C1320.14 Specifications of Air Circuit Breakers:

1	Operating voltage	380V to 690V AC
2	Insulation voltage	1000V AC
3	Dielectric strength	2.5 kV for 1 minute
4	Current ratings	As required/ as per SLD
5	Rated Service short circuit	As required/ as per SLD
6	Breaking capacity (Ics)	As required/ as per SLD
7	Rated short time withstand capacity (Icw)	As required/ as per SLD
8	Rated ultimate short breaking capacity (Icu)	As required/ as per SLD
9	Spring charging motor	self-powered
10	Protection	3 O/C and 1 E/F release/LSIG
11	Protection device	Microprocessor based release with wide selection of Current & time settings for highest degree of system discrimination & co-ordination with downstream MCCBs.
12	Features of protection device	Current setting can be changed to 40% of base - current by base - current select switch without switching OFF ACB and without changing CT tapings. Built in operation check function eliminates need for separate test instruments. Earth-Fault element incorporated in trip device with adjustable threshold: I2t (ON & OFF) time setting eliminates need for separate

		earth fault relay. LED/FLAG indication to show discrimination between over load, short circuit and E/F tripping. Trip unit malfunction/failure (self-diagnostics) shall be available on the breaker.
13	Accessories for Draw out type ACBs	Safety shutter, position switch, short circuiting contact, Mal-insertion prevention device, rating interlock padlocking, shunt trip coil, closing coil, close open cycle counter. It shall have door defeat interlock facility.
14	Shunt Trip	230V AC
15	Interlocking	OFF position Pad Lock / Door Interlock.
16	Standards & Tests	ASTA / IEC 60947-2 Category "B" IS13947-2 suitable for isolation as defined by relevant clauses in IEC 60947-2/ IS13947-2, Indian Register of Shipping Certified for shock resistant up to 70g vertical 30g horizontal for 6 msec, vibration resistant for 10-55 Hz 0.75 displacement. Rated short time withstand current (Icw) for 1 sec should be equal to the rated service breaking capacity (Ics) and equal to the ultimate breaking capacity (Icu).

C1320.15 Molded Case Circuit Breakers

C1320.15.1 **General:** Molded case circuit breakers (MCCBs) shall be incorporated wherever required and shall be of current limiting type and preferably double break. MCCBs shall conform to IS 13947-1/IEC 60947-1 for general rules and IS 13947-2/IEC 60947-2 for circuit breakers in all respects. MCCB shall be suitable for isolation as per standard, single phase 240V or three phase 380V or 415V or 440V, 50Hz, AC and shall have a rated insulation voltage of 690 V AC. The MCCBs shall have thermal memory and shall have no Line-Load restriction. All the breakers shall have tropicalisation as a standard feature.

C1320.15.2 **Construction:** The MCCB case & cover shall be made of high strength heat resistant and flame retardant thermosetting insulating material. The operating handle shall be quick make, quick break trips free type and the operating handle shall have suitable 'ON', 'OFF', 'TRIPPED' indicators. Three phase MCCBs shall have a common operating handle for simultaneous operation and tripping of all the three phases.

C1320.16 Rating & Breaking Capacity

C1320.16.1 The rating of the circuit breaker shall be as per the drawings and schedule of quantities. The MCCB shall have Service Breaking Capacity (I_{cs}) equal to Ultimate Breaking capacity (I_{cu})

C1320.17 Protection

C1320.17.1 All breakers (except MCCB Isolator) shall have thermal magnetic based trip unit as required with adjustable overload protection 80% to 100% based of the nominal current (I_n).

C1320.17.2 MCCB should have the flexibility of connecting the load either on the top or on the bottom side without deration.

C1320.18 Accessories

C1320.18.1 MCCBs shall be provided with the following accessories and all these devices shall be fitted at site. The accessories shall be separated from Power circuit. Preferably the Shunt trip release and under voltage release shall be snap-in type and fitted with terminal blocks.

- Shunt trip
- Auxiliary switch
- Extended rotary Handle.
- NO + 2NC auxiliary contacts

C1320.19 Spreader

C1320.19.1 All the MCCBs terminals should be fitted with spreaders for accommodating Aluminium cable termination.

C1320.20 Interlocking

C1320.20.1 MCCBs shall be provided with the following interlocking devices for interlocking the door of the switchboard.

- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent door being opened when breaker is in ON position.
- Door-interlock defeat to open the door even if the breaker is in ON position.
- Front operated rotary handle should have OFF-position pad-locking facility.

C1320.21 Measuring instruments

C1320.21.1 These shall be of square pattern having dimensions of 96x96 mm flush mounting type. Instruments like Multifunction Meter, ammeter, Voltmeter, frequency meter etc. and instrumental transformers/ transducers etc. are also included in the scope of supply. The accuracy class of all AC meters shall be as per schedule of quantity.

C1320.21.2 Voltmeter shall be suitable for direct line connection. Voltmeters shall be connected through MCBs only.

C1320.21.3 All voltmeters shall be provided with selector switches as per schedule of quantity.

C1320.21.4 Ammeters shall be CT operated wherever specified.

C1320.22 Current Transformers (CTs)

C1320.22.1 CTs shall be cast resin insulated type. Primary and secondary terminals shall be marked indelibly. CTs shall preferably be mounted on stationery parts. CT rating and ratios shall be as per feeder ratings. These shall be capable of withstanding momentary short circuit and symmetrical short circuit current for 1 second. Neutral side of CTs shall be earthed. Protection CTs shall have low reactance, accuracy class "5P" and an accuracy limit factor greater than "10". Instrument CTs shall be of accuracy class "1.0" and accuracy limit factor less than "5.0".

C1320.22.2 CTs used for REF protection in transformers and LT panel shall have same ratio, compatible excitation and saturation characteristics required for reliable operation.

C1320.23 Connection

C1320.23.1 Connections to the bus bars shall be made by drilling holes. However, no holes shall be left in the bus bars except at the both ends of the main bus bar for panel extension. The bolts & nuts used for connections to bus bars shall be of tinned forged brass. For tapping of connections from bus bars suitable size PVC sleeved (FRLS) copper conductor (minimum size 4.0 Sq.mm) shall be used with suitable size and type of crimped lugs/cable sockets. For connection of feeder only rigid connections with heat shrinkable PVC sleeve (FRLS) shall be used. For all outgoing cables, cable alleys of suitable sizes in sides and tops, as required for proper cable connections/laying inside the panel, shall be provided. Switch board shall be suitable for Aluminium conductor PVC insulated incoming and outgoing cables. Removable gland plates shall be provided for cable entries.

C1320.24 Earthing

C1320.24.1 Two independent earthing points shall be provided outside the panel near bottom and these shall be inter-connected with Cu earthing bus bars of minimum size 25 x 6 mm. All earthing points inside the distribution board shall be interconnected to these earthing points with suitable size copper conductor.

C1320.25 Name plates

C1320.25.1 Switch board/distribution board shall be provided with danger plate and name plates for all incoming and outgoing feeders. These name plates shall be of PVC (blue colour base & white letters engraved) screwed to panel. The size of each letters shall be 15mm x 10mm for Panel Board Identification name and remaining details shall be appropriate size and it shall be clearly visible from 1.5 meter away from the panel. PVC identification ferrule numbers shall be used for all internal wiring. The name plate shall contain the following information.

- Panel Board Identification name & number
- Feeder name.
- Switch/ fuse rating.
- Cable size.
- Feeder Cable from / to.....

C1320.26 Supports

C1320.26.1 Bus bars shall be rigidly fixed to the supports, of SMC/DMC solid block type base. Bus bars shall be firmly held within the slots in sheet type supports, which in turn shall be rigidly fixed to the chamber. The minimum clearances to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as IEC/IS standards.

C1320.27 Indicating Lamps

C1320.27.1 On all the incomers of L.V panels, ON/OFF/TRIP indicating LED lamps shall be provided, wherever specified and shall be suitable for operation on AC supply. Phase indicating LED lamps shall be associated with necessary control MCB.

C1320.27.2 Type: Panel mounting wide band LED type with inbuilt surge suppressor to protect LED against switching surges

Standards applicable : IEC 947-5-1

Diameter : 22mm

Operating voltage : 240V AC

Illumination Level : Minimum 100 lux on the front face of the lens.

Colour of lamps : as per standards

C1320.28 Arrangement of bus bars and main connections:

C1320.28.1 Bus bars and main connections, which are substantially in one plane, shall be arranged in the order given below for AC System

- The order of phase connections shall be red, yellow and blue.
- When the run of the conductors is horizontal, the red shall be on the top or farthest away as viewed from the front.
- When the run of the conductors is vertical, the red shall be on the left, or farthest away as viewed from the front.
- When the system has a neutral connection in the same plane as the phase connections, the neutral shall occupy the bottom position if horizontal and extreme right if vertical, or nearest position when viewed from the front.
- Unless the neutral connections can be readily distinguished from the phase connections, the order shall be red, yellow, blue and black.

C1320.29 Capacitors

C1320.29.1 This capacitor specification is only applicable for fixed type inbuilt capacitor in the panel. For APFC type capacitor bank the APFC specification to be referred.

C1320.29.2 Capacitor should be of heavy duty all poly propylene type. All capacitors shall be of loss less than 0.5 W / kVAr, suitable to withstand + 10% voltage variation and rated for operating temperature up to 700C. Capacitor units shall be provided of proper rating with externally mounted discharge resistors to reduce the residual voltage to less than 50 volts in one minute of switching off. Each capacitor unit shall be capable of operating continuously at 10% over voltage over and above the rated RMS voltage.

C1320.30 Series Reactor (Block Reactor)

C1320.30.1 This series reactor specification is only applicable for fixed type inbuilt capacitor bank in the panel. For APFC type capacitor bank & reactor the APFC specification to be referred.

C1320.30.2 Block reactors for connection in series with power factor correction capacitor banks to limit inrush current and resonance at harmonic frequency.

Standard	:	IS 1553 of 1990 and IEC 60289 of 1988
Rated voltage	:	as required
Type	:	Detuned, Copper wound, Iron Core dry type
Linearity	:	more than 160%
Insulation Class	:	F
Accuracy of Inductance	:	+ 1.5%
Output range	:	as required
Noise level	:	> 60 dB at rated current.

C1320.30.3 Temperature rise should not exceed 55°C above ambient with 10% harmonic current super imposed.

C1320.31 Contactors

C1320.31.1 Contactors shall comply with IS 13947:1 for general rules and IS13947-4-1 for standards pertaining to contactors and motor starters. The contactor shall be capable of withstanding breaking & making capacities per following:

C1320.31.2 The power contactors for capacitor switching should be of capacitor duty type (AC6B) with provision for reducing inrush current through a resistor, which closes prior to closing of the main contact.

C1320.31.3 The components (Over Load Relays and Contactors-main & auxiliary) inside the motor feeder shall be selected to meet Type-2 Co-Ordination and MCCB as indicated in single line schematic. Contactors shall be of AC-3 duty.

C1320.31.4 Motors for Blower fans, Agitator, compressors shall be provided with heavy-duty type Starters & suitable over load relays with delayed start time to take care of the long starting time.

C1320.31.5 Contactors shall be suitable for copper terminations with a maximum permissible temperature rise of 65°C at the terminals with an ambient temp of 50°C.

C1320.31.6 The coil shall have 3 terminals and the insulation class shall be preferably H class. The auxiliary contact block shall have a switching capacity of 440V at 2A.

C1320.31.7 Contactors shall have one auxiliary in-built contacts and it shall be possible to have additional NO & NC contacts in steps of two.

C1320.32 Push Buttons

Type	: Manually operated spring return type.
Standard applicable	: IEC947-5-1
Electric Shock protection	: Class 2 (IEC 536)
Degree of protection	: IP65
Diameter	: 22mm
Type of mounting	: Snap type
Colour of actuator	: Start PB - Green
Stop PB	: Red
Test/Reset PB	: Black
Contact configuration	: 2NO+2NC

C1320.33 Gas Based Panel Flooding System

C1320.33.1 The scope covers supply, installation, testing and commissioning, performance guaranteeing of automatic gaseous fire extinguishing CO2 based flooding system complete suitable for electrical panels with fire detection tube, cylinder, valves, and integration with fire alarm control panel for annunciation as per specifications, drawings, codes, standards and good Engineering practice etc. complete. The contractor shall be responsible to complete the entire work in all respects and any other work necessary to complete the job whether specifically mentioned or not in the scope of work. This installation shall be made in strict accordance with the specifications and applicable National Fire Protection Association Standards.

C1320.34 Applicable Standards Include

NFPA 2001	Standard for Clean Agent Fire Extinguishing Systems
NFPA 12	Standard for Carbon dioxide Fire Extinguishing Systems
NFPA 70	National Electrical Code.
NFPA 72	National Fire Alarm Code-Standard For Protective Signalling Systems.

C1320.35 The work shall cover briefly as under

- Direct fire extinguishing clean gas based flooding system.
- Providing fire detection tube inside the panels for direct systems.
- CO2 for flooding of the Panels as per specification having zero ODP and having a distinct odour for flooding system and suitable for human beings. Details of gas used shall be submitted with offer.

- Wiring /Connection to local/remote fire alarm systems (includes providing the required control modules (potential free contacts) and any other components and accessories to achieve integration with the Fire alarm system of the building).
 - Any other item required for successful commissioning of the system.
- C1320.35.1 All electrical MV main distribution panels with incomer size of 200 Amps and more in area shall be protected through localized fire trace-tube type suppression system for efficient and prompt Fire Suppression. The system consists of Polymer base tubing, CO2/inert gas cylinder and valves.
- C1320.35.2 The cylinder shall be kept near the protected area and tubing through cylinder shall be done inside the protected Panels. In case of Fire, when the flame touches the tubing and it reaches a temperature of 90-110 Deg. C the tubing bursts at its hot test point (which is nearest to the most vulnerable part of the fire), thus forming a nozzle. The pneumatic mechanism then triggers the valve of the extinguisher and sprays the agent out directly in to the fire, thus dousing the fire quicker and locally.
- C1320.35.3 Heat Sensing tube shall have the following characteristics:
- acts as a multi-sensor and multi extinguishing jet
 - made of a high-tech polymer
 - long-time resistance, flexibility and temperature sensitivity
 - when bursting at the hottest spot, it ruptures as a nozzle shape opening
- C1320.35.4 The actual net volume of the risk shall be calculated by the Contractor based on the GA Drawing of the electrical panel to be protected. CONTRACTOR shall design the system to meet the minimum requirements of total flooding fire extinguishing clean agent system as per NFPA-2001 or total flooding fire extinguishing CO2 system as per NFPA-12.
- C1320.35.5 No deviation from specification will be acceptable.
- C1320.35.6 System supplied and design calculation shall be approved by UL/FM/Vds/LPC and TAC accredited agency. All equipment shall be approved by UL/FM/Vds/LPC and cylinders along with cylinder valve assemblies shall be seamless and PESO/CCE approved. It shall be noted that system to be provided shall meet the requirements of NFPA 2001/ NFPA 12 (latest edition). *Hence anything specified as "Mandatory" in NFPA-12 or NFPA 2001, although not specifically mentioned in this specification, shall form part of this specification.*
- C1320.36 Approval of Installation
- C1320.36.1 The complete system shall be tested to meet the approval of Employer. The entire system shall be got approved from TAC (Tariff Advisory Committee, India) accredited agency by the Vendor. Only listed or approved equipment and devices shall be used in the systems i.e. all equipment shall be approved by UL/FM/Vds/LPC and cylinders along with cylinder valve assemblies shall be seamless and PESO/CCE approved.

C1320.36.2 All critical equipment such as cylinders, cylinder valves, directional valves, pressure reducers, nozzles, actuation controls, pressure gauges etc. shall have approvals from UL/FM/VDS/LPC. In order to determine that the system has been properly installed and will function as specified, the following tests shall be performed:

- A thorough visual inspection of the installed system and hazard area. The piping, operational equipment and discharge nozzles shall be inspected for proper size and location. The locations of alarms and manual emergency releases shall be confirmed. The hazard area shall be inspected closely for un-closable openings and sources of agent loss.
- A check of labelling of devices for proper designations and instructions. Name plate data on the storage cylinders shall adhere to specifications
- The cylinder along with cylinder valve assembly shall be PESO/CCE, Nagpur approved.

C1320.37 Factory Acceptance Tests

C1320.37.1 All routine tests as per IS/IEC standards shall be conducted on the Panels. CPRI / NABL test certificate for short circuit rating, temperature rise and IP classification for similar panels shall be produced. Client/consultant shall have the right to inspect the progress of work, quality of materials used/ workmanship and to witness the Routine tests after completion of work at the premises of the manufacturer. The contractor shall give at least 15 days advance information to client/consultant about the manufacturing and routine tests plan so that client/consultant can attend the same. FAT shall at least include the following tests.

- High voltage test of the bus bar system and the circuit breakers
- Functional test

C1320.38 Installation, Testing and Commissioning

C1320.38.1 Switchgears shall be installed in accordance with specified code of practice and the Consultants instructions. The panels shall be delivered in convenient shipping section by the contractors. The Contractor shall be responsible for final assembly and inter-connection of bus bars/wiring. Foundation channel shall be grouted in the flooring by the Contractor. Switchgear panels shall be aligned and levelled on their base channels and bolted or tack welded to them as per the instructions of the Employer. The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on the switchgear. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panel have been erected and aligned.

C1320.38.2 After erection the switchboard shall be inspected for dust and vermin proof. Any hole, which might allow dust or vermin etc. to enter the panel, shall be plugged suitably at no extra cost.

- C1320.38.3 If the instrument transformers are supplied separately they shall be erected as per the direction of the Employer. The Contractor shall fix the cable glands after drilling the bottom/top plates of all switch boards with suitable holes at no extra cost.
- C1320.38.4 Range of overload relays/timers (digital) etc. shall be checked with requirement of purchaser actually to be connected at site and if the same is under-sized/over-sized, it shall be brought to the notice of Employer. and shall arrange procurement of correct rated components. However, the Contractor shall not charge anything extra for cost/labour for such replacements.
- C1320.38.5 The Contractor shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of the interconnections between various items of the equipment. This shall be done by applying normal ac or dc voltage to the circuits and operating the equipment for functional checking of all control circuits, E.g. Closing, tripping, control interlock, supervision and alarm circuits.
- C1320.38.6 All connections in the switchgear shall be tested from point to point for possible grounds or short circuit. All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.
- C1320.38.7 The Contractor shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets etc. shall also have to be arranged by the Contractor. Payment for above work shall be deemed to have been included in the erection of switch boards/control panels.
- C1320.38.8 After supply and installation of panels, the contractor shall carry out following tests before switching on the power to installation and the results shall be recorded and submitted to the Employer. If results are not satisfactory/as per the standard, the contractor shall identify the defects/short coming and shall rectify the same. Nothing extra shall be paid for carrying out these tests and contractor has to arrange all necessary instruments.
- C1320.38.9 Insulation resistance tests shall be carried out by following rating insulation tester:
- | | | |
|--|---|-------|
| a) Control circuits up to 220 V
Insulation tester | : | 500V |
| b) Power circuits, bus bars, connections up to 11kV
Insulation tester | : | 1000V |
| c) Power circuits, bus bars, connections up to 33kV
insulation tester | : | 5000V |
- C1320.38.10 Before electrical panel is energized, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contact open. Before switchgear is energized, the insulation resistance of all DC control circuits shall be measured from line to ground.
- C1320.38.11 The following tests shall be performed on all circuit breakers after completion of Erection:

- Contact alignment and wipe shall be checked and adjusted where necessary in accordance with the breaker manufacturer's instructions.
- Each circuit breaker shall be closed manually and its insulation resistance measured from phase to phase and phase to ground.
- All adjustable direct acting trip devices shall be set using values approved by the Employer/manufacturer.
- Before switchgear is energized the following tests shall be performed on each circuit breaker in its test position and the same to be witnessed by the Employer
- Close and trip the circuit breaker from its local & remote control switch, push button or operating handle.
- Test operation of circuit breaker for micro process release using simulation kit (supplied along with panel).
- Test proper operation of lockout device in the closing circuit, wherever provided by simulating conditions, which would cause a lockout to occur.
- Before switchgear is energized, the test covered above shall be repeated with each breaker in its normal operating position.
- All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

C1320.38.12 The Contractor shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets etc. shall also have to be arranged by the contractor. Payment for the above work shall be deemed to have been included in the erection of switch boards/control panels.

C1320.39 Proforma for Panels

C1320.39.1 Circuit (breaker or Supplier module designation/bus no.)

1	Insulation resistance tests (contacts open, breaker racked in position)		
1.1	Between each phase of bus	:	Mega ohm
1.2	Between each phase and earth	:	Mega ohm
1.3	DC and AC control & auxiliary circuits	:	Mega ohm
1.4	Between each phase of CT/PT and	:	Mega ohm
1.5	CT & PT circuit if any	:	Mega ohm
2	CT checks	:	
3	CT ratio	:	
4	CT secondary resistance	:	
5	CT polarity check	:	

6	Check for contact alignment and wipe	:	
7	Check/test all releases/relays	:	
8	Check mechanical interlocks	:	
9	Check switchgear/control panel wiring	:	
10	Check electrical interlocks	:	
11	Checking of breaker/control circuits for	:	
12	Closing-local and remote (wherever applicable)	:	
13	Tripping-local and remote (wherever applicable)	:	
14	Opening time of breaker/contactors	:	
15	Closing time of breaker/contactors	:	

C1320.39.2 (This Performa shall be jointly signed by the Employer and the Contractor.)

C1320.40 Spares for each LT Panel

C1320.40.1 The following spares shall be supplied along with each panel without any additional cost.

1. MCB : 2 of each rating
2. MCCB : 1 of each rating
3. Indication lights : 2 of each colour
4. Ammeter : 1 of each rating
5. Voltmeter : 1 of each rating
6. Aux relay : 1 of each rating
7. Contactor : 1 of each rating
8. CT/PT : 1 of each rating

C1321 TECHNICAL SPECIFICATION FOR APFC PANEL

C1321.1 Scope

C1321.1.1 Design, manufacture, testing at works and supply and installation of Power factor improvement system with associated equipment housed inside a powder coated panel.

C1321.2 General Specification

Rated Voltage	As per Requirement
Rated Frequency	As per Requirement
No. of Phases	3 Phase - 4 Wire
Switching Option	Auto-Manual
System Fault Level	50 kA for 1 sec
Ambient temperature	45 DEG
Type	Non-Compartmentalized, Free Standing, Floor Mounted
Material	CRCA, Thickness of sheet steel of 2mm
Ingress Protection	IP 42
Installation Type	Indoor
Cable Entry	As per site condition
BUSBAR DETAILS	
Bus Bar Material	Copper, Current rating 1.2A/ SQMM
Bus bar Supports	DMC/SMC Moulded
APFC RELAY	Schneider, ABB, Siemens, L&T
Capacitor Type	Heavy Duty capacitor
Switching	Capacitor Duty Contactor
Incomer	ACB/MCCB, 50kA, NS Type with O/L & S/C
No of Steps	As per the rating

Step Protection	MCCB 25 KA with Rated Ampere rating
Current Transformer	As per rating of Panel.
Meters	Analog type : Ammeter, Voltmeter, Frequency meter.
Other Requirements	Phase Indicating Lamps (L1, L2, L3) Fans Step Indicating Lamps Control Circuit Protection – MCB Emergency Push Button Auto-Off-Manual Selector Switch On/ Off Push Button.

C1321.3 Capacitors

C1321.3.1 Capacitors shall be Heavy Duty Capacitors. A protection system shall be provided to each capacitor which shall comprise, integral discharge resistor and overpressure Disconnectors device (PSD). The discharge resistor provided, ensure that the capacitor is discharged to a voltage not exceeding 50 V measured at the capacitors terminals, one minute after disconnection from the power supply.

C1321.3.2 The capacitors shall have low-loss, units tested in accordance with IS 13340-1993/IS 13341- 1992, IEC 60831 part 1&2. Each element is of a self-healing type and manufactured using metallized polypropylene film.

C1321.3.3 Warranty of the equipment for any defects in design, material and workmanship for a period of 24 months from the date of commissioning or 30 months from the date of dispatch whichever is earlier provided the defects appear in the normal and appropriate use of the equipment and subject to having been properly stored, installed and maintained as per O&M instructions manuals.

C1322 FEEDER PILLAR BOX AT JETTY

C1322.1 Scope

C1322.1.1 This specification covers the technical requirements for design, manufacture, supply, Installation, Testing and commissioning of the outdoor type Stainless steel Feeder pillar box in the jetty.

C1322.1.2 For switchgears specification corresponding item in the LT Panel Board to be referred or corresponding IS/IEC code to be referred.

C1322.1.3 Marine Grade ACB/MCCB to be used in the Feeder pillar Boxes.

C1322.2 General Specification

C1322.2.1 Grade of SS shall be SS-316. Size shall be compact and as per the design requirement. Sufficient space to be provided to accommodate the incoming cables and outgoing cables as per the current rating. The Item shall be of outdoor type, weather proof, dust and vermin proof, free standing with suitable SS stand. Double door to be provided for outdoor installation. Door opening in front and enclosure having IP 55 degree of protection. Hinged lockable doors with door switch interlock will be provided for all feeders/panels. The Bus bar shall be coated with highly conductive material at cable connecting points for better conduction and durability at the connecting area.

- Type of product is Base mounted Welded Box.
- Box body & Door shall be made of 1.6mm SS-316.
- Gland plate shall be made of 2.0 mm SS-316.
- Front have Double leaf door provided with cam lock arrangement.
- Hingable cover shall be provided on LHS side.
- The bus bar shall be COPPER with current carrying rating as 1.2A/ SQMM if not specified separately.
- Mounting plate shall be made of GI angle 40mmX 6mm.
- Surface finish of enclosure shall be Buff finish.
- Foamed in PU Gasket with UV resistant on door and other covers.
- Shall be IP 65 compactable.
- Rest specification shall be as per relevant IS / IEC standard
- Plinth (100mm-Height) shall be made of 2.0mm SS-316.

C1322.2.2 Factory acceptance test and site acceptance test shall be carried out as per the IS/IEC standard or as specified in the LT panel Board specification.

C1322.2.3 433 volt A/C, 50 C/s, 3 phase Feeder Pillar Box (7 Nos.):

C1322.2.4 Feeder pillar box shall be of outdoor KIOSK type cubicle weather and vermin proof suitable for 433 volt A/C, 50 C/s, 3 phase and neutral and fabricate from 2mm thick stainless steel sheet on suitable angle iron frame with shutters locking arrangement etc. comprising the following: -

- (i) 2000 Amps ACB-01 No (Incoming)
- (ii) 630Amps ACB -04 Nos (Outgoing)
- (iii) 200 Amps MCCB - 02 Nos (Outgoing)
- (iv) 100 Amps MCCB - 02 Nos (Outgoing)
- (v) Cope box 100 A -02 Nos (Outgoing)

- C1322.2.5 440 volt A/C, 60 C/s, 3 phase Feeder Pillar Box (4 Nos.)
- C1322.2.6 Feeder pillar box shall be of outdoor KIOSK type cubicle weather and vermin proof suitable for 440 volt A/C, 60 C/s, 3 phase and neutral and fabricate from 2mm thick stainless steel sheet on suitable angle iron frame with shutters locking arrangement etc. comprising the following: -
- (i) 1600 Amps ACB-01 No (Incoming)
 - (ii) 800 Amps ACB -02 Nos (Outgoing)
- C1322.2.7 380 volt A/C, 50 C/s, 3 phase Feeder Pillar Box (4 Nos.)
- C1322.2.8 Feeder pillar box shall be of outdoor KIOSK type cubicle weather and vermin proof suitable for 380 volt A/C, 50 C/s, 3 phase and neutral and fabricate from 2mm thick stainless steel sheet on suitable angle iron frame with shutters locking arrangement etc. comprising the following: -
- (i) 1600 Amps ACB- 01 No (Incoming)
 - (ii) 800Amps ACB - 03 Nos (Outgoing)
 - (iii) 100 Amps MCCB - 01 Nos (Outgoing)
 - (iv) Cope box 100 A - 01 Nos (Outgoing)
- C1322.3 Loop in loop out Box for Vessel Supply
- C1322.3.1 This specification covers the technical requirements for design, manufacture, supply, Installation, Testing and commissioning of the outdoor type Stainless steel Loop in loop out for vessel supply at jetty.
- C1322.4 General Specification
- C1322.4.1 Grade of SS shall be SS-316. Size shall be as per the drawing attached and in side space of box shall be have sufficient size to accommodate the incoming cables and outgoing cables as per the current rating. The Item shall be of outdoor type, weather proof , free standing with suitable SS stand, dust and vermin proof, neoprene rubber gasket or high quality , suitable with double door for outdoor installation , door opening in front and canopy having IP65 degree of protection of enclosure. The Bus bar shall be coated with highly conductive material at cable connecting points for better conduction and durability.
- C1323 LOOP IN LOOP OUT BOX FOR COPE BOX SUPPLY**
- C1323.1 Scope
- C1323.1.1 This specification covers the technical requirements for design, manufacture, supply, Installation, Testing and commissioning of the outdoor type Stainless steel Loop in loop out for Cope box supply at jetty.

C1323.2 General Specification

C1323.2.1 Grade of SS shall be SS-304. Size shall be as per the drawing attached and inside space of box shall be have sufficient size to accommodate the incoming cables and outgoing cables. The Item shall be of outdoor type, weather proof , with supports of SS make with suitable size and capable of fixing under the berth slab along the cable duct were cables is being routed for taking supply to vessels etc. dust and vermin proof suitable with Cover /Door for outdoor installation , door opening in front and canopy having IP65 degree of protection of enclosure. The Bus bar shall be coated with highly conductive material at cable connecting points for better conduction and durability.

C1324 COPE BOX PANEL AT JETTY

C1324.1 Scope

C1324.1.1 This specification covers the technical requirements for design, manufacture, supply, Installation, Testing and commissioning of the outdoor type Stainless steel Cope box supply point panel with receptacle at jetty.

C1324.2 General Construction

C1324.2.1 The item shall be surface mounted receptacle combination enclosure with stainless steel grade of 316 suitable for marine environmental use. The panel is for use in the marine environments and shall have grater resistance to pitting. The item shall be compact austenitic chromium – nickel stainless and heat resistance steel with superior corrosion resistance. Hinged lockable doors with door switch interlock will be provided for all feeders/panels, door opening in front and canopy and having IP 55 degree of protection for enclosure. The receptacles/ sockets shall be high resistance polycarbonate material. The panel shall be fitted with 12 W LED lamp fittings with switch, MCB for getting outside illumination for working purpose. The item shall be of branded and reputed make having manufacturing facility according to DVE, TUV, Lloyd 's, or equivalent. Relevant certificate shall be produced for approval. Makes Hensel, Menekes or equivalent reputed/ branded make having experience in marine field application. For other makes, approval from the Employer has to be taken and discretion of the Employer is final. Tentative rating and quantity of the cope box is given below. However, contractor has to supply the item as per the detailed design requirement.800A Cope Box (20 Nos):

C1324.2.2 Cope box on suitable foundation, bolts, connect test and commissioning independent, floor mounted fabricated of 2 mm stainless steel sheet including electrolytic copper 3 phase bus bar of 800A.

C1324.3 1200A Cope Box (12 Nos)

C1324.3.1 Cope box on suitable foundation, bolts, connect test and commissioning independent, floor mounted fabricated of 2 mm stainless steel sheet including electrolytic copper 3 phase bus bar of 1200A.

C1324.4 300A Cope Box (8 Nos.)

C1324.4.1 Cope box on suitable foundation, bolts, connect test and commissioning independent, floor mounted fabricated of 2 mm stainless steel sheet including electrolytic copper 3 phase bus bar of 300A.

C1325 CABLES & CABLES INSTALLATION

C1325.1 Scope

C1325.1.1 The scope under this section covers the sizing of power cables as per load current and fault level, preparation of cable schedule, manufacture, supply, factory testing, transportation, storage and installation of power & control cables.

C1325.1.2 Incoming 11kV cable from MES substation to North jetty substation shall be of Aluminium Cable

C1325.1.3 Outgoing cables from North Jetty substation to Jetty area through the Service gallery shall be of copper.

C1325.1.4 Cables running inside the Power house and feeding to other building shall be of copper or Aluminium according to the cable size.

C1325.1.5 Cables of less than 16sq.mm shall be of copper and above 16sq.mm shall be of Aluminium including 16sq.mm

C1325.1.6 Power cables shall be sized to satisfy the following Criteria:

C1325.1.7 Short circuit withstand capacity for applicable fault current and duration.

C1325.1.8 Full load current carrying capacity under installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.

C1325.1.9 Permissible voltage drops limits under steady state/transient state as applicable.

C1325.1.10 Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Cables shall be sized for the following short circuit rating.

- Outgoing cables from 11kV Switchboards: 26.3 kA for 0.16 sec.
- Incoming cables to 415V/380V Main Panels: 50 kA for 1 sec.(Breaker operated)
- Incoming cables to 415 V MCC/DB : Fuse cut-off current for 10 milli second (MCB protected)
- Cables from 415 V MCC to Motors: 50 kA for 0.16 sec ACB operated
- Feeders from MCC/DB : Fuse cut-off current for 10 milli second (MCB protected)
- To maintain voltage at motor terminals / equipment end with in desirable limit, it is proposed to limit the voltage drop in the cables within the following limits:

Steady state Voltage drop (Continuous running condition): 2.5%

Transient state voltage drop (During Motor Starting) : 10 %

C1325.2 Standards

C1325.2.1 The following standards, amended up to date, shall be applicable:

IS: 1753: Specification for Aluminium conductors for insulated cables.

IS: 2982: Specification for copper conductors in insulated cables.

IS: 5831: Specification for XLPE insulated and PVC sheath of electric cables.

IS: 6474: Polythene insulation and sheath of electric cables.

IS: 3975: Specification for mild steel wires, strips and tapes for armoring of cables

IS: 694: PVC insulated cables.

IS: 7098: Specification for XLPE insulated PVC sheathed cables.

IS: 3961: Recommended current ratings of cables.

IS: 5819: Recommended short circuit ratings for high voltage PVC cables.

IS: 8130: Conductors for insulated electric cables

IS: 1554: Specification for PVC insulated (Heavy duty) Electric cable

C1325.3 Armoring and Serving

C1325.3.1 All multicore cables liable for mechanical damage shall be armoured.

C1325.3.2 The armoring for cables above 16 sq.mm shall be galvanized steel strips and 16sqmm & below shall be with galvanized steel round wire.

C1326 STORAGE AND HANDLING

C1326.1 Storage

- The cable drums shall be stored on a well-drained, hard surface, so that the drums do not sink in the ground causing rot and damage to the cable drums paved surface is preferred, particularly for long term storage.
- The drums shall always be stored on their flanges, and not on their flat sides.
- Both ends of the cables should be properly sealed to prevent ingress/absorption of moisture by the insulation during storage.
- Protection from rain and sun is preferable for long-term storage for all types of cables. There should be enough ventilation between cable drums.
- Damaged battens of drums etc. should be replaced, as may be necessary.

C1326.2 Handling

- When the cable drums have to be moved over short distances, they should be rolled in the direction of the arrow marked on the drum.

- For manual transportation over long distances, the drum should be mounted on cable drum wheels, strong enough to carry the weight of the drum, and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.
- For loading into and unloading from vehicles, a crane or a suitable lifting tackle should be used. Small sized cable drums can also be rolled down carefully on a suitable ramp or rails, for unloading, provided no damage is likely to be caused to the cable or to the drum.

C1326.3 Power cables (HV) 11 kV grade XLPE insulated FRLSH cable

C1326.3.1 The conductors shall be screened by extruded compound and XLPE insulated. The cores shall be screened by extruded compound in combination with non-metallic tape. The inner sheath over laid up cores and outer sheath over the armour shall be extruded black PVC compound type ST-2, FRLSH type. Core identification shall be by printed numerals. The inner and outer sheath should be separated by steel armouring. The construction, performance and testing of the cable shall comply with IS: 7098-part-2. Dry cure (Radiant curing process) technology should be used for the manufacturing of cross-linked polyethylene cable.

C1326.3.2 Bi-metallic plate washers should be provided wherever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible.

C1326.4 General details

Cross sectional area of conductor	:	as per design calculation
No. of cores	:	3
Conductor	:	Aluminium

C1326.5 Insulation

C1326.5.1 The thickness of insulation shall be on the basis of insulation material, voltage and conductor size conforming to the relevant standard specification. The cores shall be colour coded to IS specifications. The XLPE insulation & sheathing shall be of high quality.

C1326.6 Sheathing

C1326.6.1 The sheathing shall be PVC and shall be before and after the armouring, the thickness of the sheathing shall be based on the conductor size and overall diameter below the sheathing.

C1326.7 Armouring

C1326.7.1 Single core cables shall be armoured with earthed at one end and if insisted it shall be of nonmagnetic material. Multi core cables shall be with armouring.

- C1326.8 Power Cable termination
- C1326.8.1 Cable termination shall be heat shrinkable type and the bushings shall be covered with adequate insulation with a provision for using the cable test rods for cable testing. 11kV cable compartments for each circuit shall be separately enclosed. Cable termination shall be suitable for Aluminium conductor. Suitable cable termination kits and other accessories shall be included in the scope of supply. Bi-metallic plate washers should be provided where ever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible. The cable should be properly terminated to avoid stress on end termination.
- C1326.8.2 End termination must be done by an authorized cable jointer approved by the manufacturer or a qualified cable jointer.
- C1326.9 Power cables (LV) 1.1kV grade XLPE insulated FRLSH cable
- C1326.9.1 Power cables for use on 440V/415V/380V system shall be of 1100 volt grade, Aluminium/Copper conductor, XLPE insulated, PVC sheathed, armoured and overall PVC sheathed cable of FRLSH type, strictly as per relevant IS specification. Bi-metallic plate washers should be provided where ever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible.
- C1326.9.2 The size of these cables shall be as per design calculation.
- C1326.10 Control Cables
- C1326.10.1 Control cables for use on 415V system shall be 1100 volts grade, copper conductor, FRLSH insulator. Unarmoured cables to be used only if specifically required. Control cable carrying current should be black colour and voltage circuit shall be of grey colour and shall be segregated.
- C1326.10.2 The size of these cables shall be as per design requirement. No cable of size less than 1.5 sq.mm, shall be used.
- C1326.10.3 Inter tripping control cable to be considered between the North jetty substation and MES substation for interlock with the upstream breakers.
- C1326.11 Cable Glands
- C1326.11.1 Cable glands shall be of heavy duty double compression type of brass, chrome plated. These shall have a screwed nipple with conduit electrical thread and check nut. These shall be suitable for armoured/unarmoured cables, which is being used.
- C1326.12 Cable Connectors
- C1326.12.1 Cable connectors, lugs/sockets, shall be of copper/Aluminium alloy, suitably tinned, solderless, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments, etc.)
- C1326.13 Cable Indicators
- C1326.13.1 These shall be 0.5 mm thick stainless steel/Cu strap for overall cable. PVC identification numbers, ferrule shall be used for each wire.

- C1326.14 Cable Route Markers
- C1326.14.1 Cable route markers shall be provided at 50-meter interval for underground cables.
- C1326.15 G.I. Pipes for Cables
- C1326.15.1 For laying of cables under floor, ground etc. G.I. class 'B' pipes shall be used. MS conduits is not acceptable for this purpose. All accessories of pipes shall be threaded types. Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe. No G.I pipe less than 40 mm dia. shall be used for this purpose. To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.
- C1326.16 Factory Acceptance Test
- C1326.16.1 Representative of the Employer shall have free access to vendor's works to inspect, expedite and witness shop tests. Any materials or works found to be defective or which does not meet the requirements of this specification will be rejected and shall be replaced at Vendor's cost.
- C1326.16.2 All routine tests shall be carried out on the cables as per relevant Indian Standard/
- C1326.16.3 specifications and will be witnessed by the Employer.
- C1326.16.4 Routine test certificates as well as Type test certificates for the type tests carried out on identical cables shall be furnished to the Employer for reference and records.
- C1326.17 Installation, Testing and Commissioning
- C1326.17.1 Cable network shall include power, control and lighting cables, which shall be laid in underground trenches, Hume pipes, open trenches, cable trays, GI pipes, or on building structure surfaces as detailed in the relevant drawings cable schedules or as per the Employer instructions. Supply and installation of cable trays, GI pipes/conduits, cable glands sockets at both ends, isolators, junction boxes, remote push buttons stations, etc. shall be under the scope of the Contractor.
- C1326.18 General requirements for handling of cables
- C1326.18.1 Before laying cables, these shall be tested for physical damage, continuity, absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500/1000 volt in the insulation tester.
- C1326.18.2 The cables shall be supplied at site, wound on wooden drum as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable shall be rolled on, as it produces kinks which may damage the conductor.
- C1326.18.3 Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall not be less than 15 D Where 'D' is overall diameter of the cable.

- C1326.18.4 While drawing cables through GI pipes, conduits, RCC pipe, ensure that size of pipe is such that, after drawing cables, 40 % area is free. After drawing cable, the end of pipe shall be sealed with cotton/bituminous compound.
- C1326.18.5 High voltage (11 kV and above), medium voltage (230 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes/trays.
- C1326.18.6 Armoured cables shall never be concealed in walls/floors/ roads without GI pipes, RCC pipes.
- C1326.18.7 Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of the Employer shall be taken. If allowed, proper straight through epoxy resin type/ shrinkable joint shall be made, without any additional cost.
- C1326.18.8 A minimum loop of 3 M shall be provided on both ends of the cable, laid in ground. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.
- C1326.18.9 Cable shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor.
- C1326.18.10 All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings is indicative only and the same may be rechecked with the Employer before cutting of cables. While selecting cable routes, interference with structures, foundations, pipe line, future expansion of buildings, etc. should be avoided.
- C1326.18.11 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.
- C1326.18.12 Wherever cable rises from underground/concrete trenches to motors/switchgears/push buttons, these shall be taken in GI pipes of suitable size, for mechanical protection up to 300 mm distance of concerned cable gland or as instructed by the Employer.
- C1326.18.13 Where cables pass through foundation/walls of other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical Contractor shall determine their location and obtain approval of the Employer before cutting

- C1326.19 Installation of Cables
- C1326.19.1 Wherever cables are taken through masonry works and road crossings etc., they shall be protected by running through GI pipes or Hume pipes. Depth shall be 1200 mm from top of finished road surface and it shall extend for about 1070 mm on both sides of the roads.
- C1326.19.2 Utmost care shall be taken to avoid scratches, kinks and cuts on the conductor while transporting the cables to site or during installation. Suitable inhibiting grease shall be liberally applied to bare conductors, wherever they exist.
- C1326.19.3 The junction boxes, cable end boxes etc. wherever required to be provided shall have sufficient wiring spaces with regard to the sizes of cables indicated in the drawings. Wherever required, the items to be supplied for electrification shall be complete with requisite type of cable glands, cable boxes, termination etc. and other accessories which are necessary for the satisfactory installation/operation of the installations as per relevant statutory rules and regulations.
- C1326.19.4 Installation of all cables should be as per Standards. Fuses should be graded properly and should be selected based on the rating of cables. The cables shall be laid in trenches/overhead racks wherever available. The cables from cable trenches to the switcher shall be buried (as per standard practices and or taken through GI pipes to 1.2 m above ground/racks floor level. The cables taken over racks/ walls/ columns/ Transformers shall be properly clamped using aluminium clamps, the width varying from 12.5 to 25 mm at intervals of 750 mm. Suitable and permanent type of cable markers is to be provided indicating the route and position of joints of cable. Loops should be provided at either ends of the cable. Identification tags should be provided for each cable in the trench at a distance of 10 metres.
- C1326.19.5 Supply and installation of danger notice boards, where required, and other provisions under the statutory rules and regulations shall be in the scope of this work.
- C1326.19.6 The Contractor has to provide materials and carry out the wiring work including earthing according to IS 3043 unless otherwise specified and get it approved before using for work, by the Employer.
- C1326.19.7 Sufficient number of earth pits shall be provided, if found necessary and inter-connected so as to have the resistance of the earthing installations not more than 0.5 ohm. In case the soil resistivity is found to be very high, a high sensitive relay may be used to co-relate the relay setting with high earth resistance.
- C1326.19.8 The complete installation work shall be conforming to NEC-2014 and complying with the Safety Regulations 2010 and to meet the approval of the State Electrical Inspector. Installation of all switch boards and distribution boards should be in conformity with Safety Regulations 2010 and I.S. 732/1989.
- C1326.19.9 The cable terminations and earth terminations, wherever required, shall only be using double compression type cable glands and suitable lugs.
- C1326.19.10 All the materials to be supplied for this work shall be got approved by the Employer.

C1326.19.11 The work will be considered complete only if the following tests are conducted, by the contractor at his own cost, satisfactorily in the presence of the Employer and are:

- Insulation test
- Earth resistance test and
- Continuity test
- High pot test (for High voltage cable only)

C1326.20 Laying of Cables (underground system)

C1326.20.1 Cables shall be so laid in ground that these will not interfere with other underground structures. All water pipes, sewage lines or other structures, which become exposed by excavation, shall be properly supported and protection from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded diverted as directed by the Employer.

C1326.20.2 Cables shall be laid at minimum depth of 750 mm in case of LT & 1200 mm in case of HT, from ground level. Excavation will be generally in ordinary alluvial soil. The width of the trench shall be sufficient for laying of required number of cables.

C1326.20.3 Sand bedding using quarry sand of 75 mm thick shall be made below and above the cables. A layer of protecting covering with solid concrete block of 300 X 200 X 50 mm shall be laid breadth wise, above quarry sand bedding to cover cable completely. More than one cable can be laid in the same trench. However, the relating location of cables in trench shall be maintained till termination. The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounded ground and to the entire satisfaction to the Employer.

C1326.20.4 For all underground cables, route markers should be used.

C1326.20.5 Separate cable route markers should be used for LT, HT and telephone cables.

C1326.20.6 Route markers should be placed in ground with 1:2:4 cement concrete pedestal

C1326.20.7 Cable markers should be installed at an interval not exceeding 50 M along the straight routes of cables at a distance of 0.5 M away from centre of cable with the arrow marked on the cable markers plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.

C1326.20.8 RCC Hume pipes for crossing road in cable laying shall be provided by Contractor. RCC Hume pipe at the ends shall be sealed by bituminous compound after laying and testing of cable by the Contractor without any extra charge.

- C1326.21 Laying of Cables (Under Floors)
- C1326.21.1 GI class-A pipe shall be used for laying of outgoing cables from distribution boards to various equipment. Preferably one cable shall be drawn through one pipe. Size of pipe shall be such that after drawing of cable, 40 % area is free. If length of pipe is more than 30 M, free area may be increased to 50 %.
- C1326.21.2 Use of elbows is not allowed at all and number of bends shall be kept minimum. Instead of using bends with sockets, pipe bending machine shall be used for making long smooth bends at site.
- C1326.21.3 Ends of pipe shall be sealed temporarily while laying with cotton/jute/rubber stopper etc. to avoid entry of building material, without any additional cost.
- C1326.21.4 Exact locations of equipment shall be ascertaining prior to laying of pipe.
- C1326.22 Laying of Cable in Masonry Trenches
- C1326.22.1 Masonry/concrete trenches for laying of cable shall be provided by Contractor. However, steel members such as MS angles/flats etc. shall be provided & grouted by electrical Contractor to support the cables. Cables shall be clamped to these supports with aluminium saddles/damps. More than one tier of cables can be provided in the same trench if the number of cables is more.
- C1326.22.2 Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches, without any additional cost.
- C1326.23 Laying of Cables in Cable Racks
- C1326.23.1 Cable Racks to be used for cables laid indoors except for single cables. The cable racks shall be of ladder type fabricated out of structural steel, MS, GI or aluminium perforated as indicated. The cable racks shall be of adequate strength to carry the weight of cables without sagging. Structural bracket grouted in the build-up trenches to support the cable such supports shall be at intervals of not less than 750 mm centres. All the structural steel work shall be finished with two coats of paint over primer.
- C1326.23.2 Cables shall be fixed in cable trays in single tier formation and shall be clamped with aluminium flat clamps and galvanized bolts/unit.
- C1326.23.3 Earthing flat/wire can also be laid in cable tray along with cables.
- C1326.23.4 After laying of cables minimum 20 % area shall be available for future use.
- C1326.24 Laying of Cables on Building Surface/Structure
- C1326.24.1 Such type of cable laying shall be avoided as far as possible and will be allowed only for individual cables or small group of cables which run along structure.
- C1326.24.2 Cables shall be rigidly supported on structural steel/masonry using individual cast/malleable iron galvanised saddles and these supports shall be approximately 400 to 500 mm for cables up to 25 mm overall diameter and maximum 1000 mm for cables larger than 25 mm. Unsightly sagging of cables shall be prevented. Only aluminium/GI clamps with GI bolts/nuts shall be used. Clamping of cable to be done at minimum 1.5-meter interval.

C1326.24.3 If drilling of steel structure must be resorted to, approval must be secured from the Employer and steel must be drilled where the minimum weakening of the structure will result.

C1326.25 Laying of Cable in HDPE pipe

C1326.25.1 For road, entry into buildings and paved areas cables shall be drawn through HDPE pipes . Pipe shall be of 110mm dia and wall thickness not less than 5mm. Top of pipe shall be not less than 750 mm from the top surface..

C1326.25.2 All pipes shall be provided with a fish wire. Where cables have been drawn the ends shall be plugged with bituminized tape over the cables for water proofing. For longer distances and at bends draw-pits of adequate size shall be provided to facilitate drawing in of cable, if necessary. The HDPE pipes shall be joined together, if necessary, with PVC/HDPE coupling or through the Butt joint. Supply of the jointing material shall also be borne by the contractor.

C1326.26 General Information

C1326.26.1 Laying of cables shall be carried out by skilled and experienced labourers using adequate rollers to minimize stretching of the cable/external damage to cables. Cables shall not be bent below the minimum permissible limit.

C1326.26.2 The permissible limits are as follows:

Type of cable & voltage grade	Minimum bending radius Power cable
Power cable	12D
Control cables	10D
Note: D is overall diameter of cable	

C1326.26.3 In each cable run some extra length shall be kept at a suitable point to enable one (for LT Cables) or two (for H.T cables) straight through joints to be made, should the cable develop fault at a later date. Metal screen and armour of the cable shall be bonded to the earthing system of the station on the receiving and the sending end.

C1326.26.4 The erection work shall be carried out in a neat workman like manner and the areas of work shall be cleaned of all scrap materials, etc. after the completion of work in each area every day.

C1326.26.5 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost, and to the satisfaction of the Employer. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable, at no extra cost i.e. the Contractor shall not be paid for installation and removal of the damaged cable. All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs with insulating tape, sleeve or paint.

- C1326.27 Drawing of cable by HDD & Method of Drilling
- C1326.27.1 There are 3 road crossings and one rail crossing in the cable routes. Cable shall be drawn through these crossings by horizontal direct drilling at a minimum depth of not less than 3m except at both ends. The length of the route for providing HDD shall be minimum possible and shall be finalized after the approval of Employer.
- C1326.27.2 HDD shall be done with 110 mm HDPE pipe having thickness of not less than 5mm as referred in ASTM D 1505.
- C1326.27.3 The pipe shall be pulled through the borehole of sufficient depth & size after successfully reaming the borehole. Once pull back operations have commenced, the operation must continue without interruption until the pipe is completely pulled through the reamed hole.
- C1326.27.4 The Contractor shall take all care and necessary precautions to protect existing structures, utilities and services in planning and execution of the Works for which the contractor shall carry out proper sounding before starting the HDD work.
- C1326.27.5 Any damage to adjacent properties that are not part of this work shall be repaired and restored to its original condition at the Contractor's expense. The Contractor shall be responsible for the identification and protection of services where these are crossed by construction activities.
- C1326.27.6 Where crossing of roadways and railways are involved, the Contractor shall be required to record and report any ground settlement to the satisfaction of the controlling agencies. Where utilities and pipelines are involved the Contractor shall monitor ground settlement or heave directly above and 3m before and after the utility or pipeline intersection. The Contractor shall cease operations when monitoring points indicate any surface disruption. Necessary clearances from the concerned authority shall be obtained by the contractor.
- C1326.27.7 All necessary measures must be taken to ensure that excavations are left in a safe condition, including the erection of suitable hard barricades, warning signs and hazard lights. The earthworks shall be set out in accordance with the design drawings.
- C1326.27.8 All excavations shall be made to the depth and extent as shown on the Drawings with proper allowance for fill, additional cover (where required) and formwork. The excavations shall be kept free and clear of loose materials, water and rubbish.
- C1326.27.9 After satisfactory completing, excavated materials for the HDD operations shall be removed, the Contractor shall prepare the bottom of all pits to the same specification as required for the pipe foundation. The Contractor shall ensure that the terminal sections of pipe that are joined are connected with Central Plastics Electrofusion Couplings, or connectors with tensile strength equivalent to that of the pipe being joined.

- C1326.27.10 The Contractor shall undertake works in accordance with appropriate safety requirements by local & state regulations. Safety measures shall include, but not be limited to, personal protective equipments, operating of machinery within job site, and storage and transportation of materials and equipments.
- C1326.27.11 After the HDD work, the HT cable shall be drawn through the pipe as per the schedule. Due Care shall be taken not to damage the cable while drawing.
- C1326.27.12 Cable tags, Name plate for Panels, Equipment, schematic diagram of installations etc. and marker
- C1326.27.13 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule. The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS: 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables. Alternately, the contractor may provide cable tags made up of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.
- C1326.27.14 The name plate materials shall be flame proof and clearly visible and durable. Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate. Location of underground cable joints shall be indicated with cable marker with an additional inscription—Cable joint.
- C1326.27.15 The markers shall project 150mm above ground and shall be spaced at an interval 100 meters and at every change in direction. They shall be located on both sides of road and drain crossings. Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, such as where a number of cables enter together through a gland plate.
- C1326.27.16 The price of cable tags , name plates , Schematic diagram and markers shall be included in the installation rates for Cables / Conduits / Equipment quoted by the Contractor. Specific requirements for cabling, wiring ferrules as covered in respective equipment section shall also be complied with. Schematic diagram of installations with cable routing shall be made in PVC material .
- C1326.28 RCC Cable Route Marker
- C1326.28.1 Route markers shall be provided along the runs of cables at locations approved by the Employer and generally at interval as suggested by Employer. Markers shall also be provided to identify change in the direction of the cable route and at locations of underground joints. Route markers shall be fixed firmly with cement concrete.

- C1326.28.2 Route identifiers shall be made out of RCC in 1:2:4 (cement: 2coarse sand: 4graded stone aggregate of 20mm in size)of size 750x30x10 shall be laid and centred over the cable. The concrete markers, shall project over the surrounding surface so as to make the cable route easily identifiable. The reinforcement shall be with 10 SWG MS rod having the size of 50mmx50mm
- C1326.28.3 The words '**11 KV CABLE/ JOINT-2020**' as the case may be, shall be engraved / inscribed on the marker.

C1327 TERMINATION AND JOINTING OF CABLES

C1327.1 Use of Glands

C1327.1.1 All PVC cable up to 1.1 kV grade, armoured or unarmoured shall be terminated at the equipment/junction box/ isolators/push buttons/control accessories, etc. by means of suitable size double compression type cable glands armour of cable shall be connected to earth point. The Contractor shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanised threaded reducing bushing shall be used for approved type.

C1327.1.2 In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, a close fit holes should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.

C1327.2 Use of Lugs/Sockets

C1327.2.1 All cable leads shall be terminated at the equipment terminals, by means of crimped type solder less connectors unless the terminals at the equipment ends are suitable for direct jointing without lugs/sockets.

C1327.2.2 The following is the recommended procedure for crimped joints and the same shall be followed:

C1327.2.3 Strip off the insulation of the cable end with every precaution, not to severe or damage any stand. All insulation to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.

C1327.2.4 The cable should be kept clean as far as possible before assembling it with the terminal/socket. For preventing the ingress of moisture and possibility of re-oxidation after crimping of the aluminium conductors, the socket should be fitted with corrosion inhibiting compound. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.

C1327.2.5 Correct size and type of socket/ferrule/lug should be selected depending on size of conductor and type of connection to be made.

C1327.2.6 Make the crimped joint by suitable crimping tool.

C1327.2.7 If after crimping the conductor in socket/lug, same portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape (FRLSH).

C1327.3 Dressing of Cable inside the Equipment

- C1327.3.1 After fixing of cable glands, the individual cores of cable shall be dressed and taken along the cableways (if provided) or shall be fixed to the panels with polyethylene straps. Cable shall be dressed in such a manner that small loop of each core is available inside the panel.
- C1327.3.2 For motors of 20 HP and above, terminal box if found not suitable for proper dressing of an Aluminium cables, the Contractor shall modify the same without any additional cost.
- C1327.3.3 Cables inside the equipment shall be measured and paid for.
- C1327.4 Identification of Cables/Wires/Cores
- C1327.4.1 Power cables shall be identified with red, yellow & blue PVC tapes (FRLSH) for trip circuits' identification, additional red ferrules shall be used only in the particular cores of control cable at the termination points in the switchgear/control panels and control switches.
- C1327.4.2 In case of control cables all cores shall be identified at both ends by their wire numbers by means of PVC ferrules or self-sticking cable markers, wire numbers shall be as per schematic/connection drawing. For power circuit also wire numbers shall be provided if required as per the drawings of switchgear manufacturer.
- C1327.4.3 Brief Specification of reinstating of hard surfaced area:
- (i) Back filling the trenches with crusher run screenings.
 - (ii) Tarred area - Providing thick rubble soling, wet mix macadam, applying priming coat with bitumen emulsion, applying tack coat over bitumen emulsion, laying 50mm thick bituminous macadam, laying 75mm thick bituminous concrete .
 - (iii) In Cement concrete area, re-concreting shall be done.
 - (iv) Transporting surplus earth to location as directed by Employer.
- C1327.5 Testing of Cable at Site
- Before energising, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.
 - Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Report measurements after splices and/or terminations are complete.
 - DC High Voltage test shall be made after installation on the following:
 - All 1100 Volts grade cables in which straight through joints have been made.
 - All cables above 1100 V grade.
 - For record purposes test data shall include the measured values of leakage current versus time.

- The DC High Voltage test shall be performed as detailed below:
 1. Cables shall be installed in final position with the entire straight through joints complete. Terminations shall be kept unfinished so that motors, switchgear, transformer etc. are not subjected to test voltage.
 2. The test voltage and duration shall be as per relevant codes and practices of Indian Standards Institution.

C1328 PROFORMA FOR TESTING CABLES

C1328.1 Proforma – A, for Cable Preparation

- 1 Date of Test
- 2 Drum No. from which cable taken
- 3 Cable From..... To.....
- 4 Length of run of this cable in
metre
- 5 Insulation resistance test:
 - Voltage of Megger Volts
 - Between core-1 to earth Mega ohm
 - Between core-2 to earth Mega ohm
 - Between core-3 to earth Mega ohm
 - Between core-1 to core-2 Mega ohm
 - Between core-2 to core-3 Mega ohm
 - Between core-3 to core-1 Mega ohm
- 6 High voltage test Voltage..... Duration.....
 - Between cores and earth
 - Between individual cores

Signature of Employer

Signature of Contractor

C1328.2 Proforma – B, for Cable Laying
 (To be shown for each cable separately, voltage wise)

1	Date(s) of Test	.....	
2	Type of Cable			
3	Cable running between	From.....	To.....	
4	Length of run of this cable in metre			
	Before laying		Before back filling	
5	Continuity of Cores	.....	Continuity of Cores	of
6	Voltage of Megger used			.....
7	IR Value Between	(Mega Ohms)	IR Value Between	(Mega Ohms)
	R-N	.....	R-N	.....
	Y-N	.....	Y-N	.....
	B-N	.....	B-N	.....
	R-Y	.....	R-Y	.....
	B-R	.....	B-R	.....
	Y-B	.....	Y-B	.....
	R-E	.....	R-E	.....
	Y-E	.....	Y-E	.....
	B-E	.....	B-E	.....

Signature of Employer

Signature of Contractor

C1328.3 Proforma – C, for Cable Jointing

(To be shown for each cable separately, voltage wise)

- 1 Date(s) of Test
- 2 Voltage of Megger used
- 3 Number of Joint
- 4 Location
- 5 Type of cable(s)
- 6 Type of joint (Indoor/Outdoor, straight through/termination, LV/MV/HV)
- 7 Insulation resistance measurement

Insulation resistance (Mega ohm)	Before jointing		Jointed Cable
	Cable-I	Cable-II	
R-N
Y-N
B-N
R-Y
B-R
Y-B
R-E
Y-E
B-E

Signature of Employer

Signature of Contractor

C1328.4 Proforma – D, for Testing of Cable before Commissioning

- 1 Cable Work
- 2 Date(s) of Test
- 3 Details of high Voltage test conducted
- 4 System of supply
- 5 Test Voltage appliedKVMinutes
- 6 Result of test Satisfactory/Unsatisfactory.
- 7 Voltage of Megger used
- 8 Result of Megger testing

Insulation resistance (Mega ohm)	Before HV Test	After HV Test
R-N
Y-N
B-N
R-Y
B-R
Y-B
R-E
Y-E
B-E

Signature of Employer

Signature of Contractor

C1329 HDPE (HIGH DENSITY POLYETHYLENE) PIPE

C1329.1 Scope

C1329.1.1 The specification provides for manufacture and delivery of HDPE pipe.

C1329.2 Application

C1329.2.1 HDPE pipe shall be provided for laying the HT/LT cable at road crossing/hard surfaces.

C1329.3 Technical requirements

C1329.3.1 The HDPE pipes shall be 150 MM dia. or as per cable diameter: with thickness of not less than 5 mm. The HDPE pipe shall be made from high-density polyethylene (HDPE) resins meeting the following requirements:

C1329.3.2 The HDPE material supplied under this specification shall be high density, high molecular weight conforming to relevant IEC/BIS. The HDPE material shall conform to ASTM D 3350. Suitable size PVC flexible pipe with collar shall be provided for the end portion of HDPE pipe.

C1330 LIGHTING SYSTEM

C1330.1 Scope

C1330.1.1 This specification covers the requirements of Illumination system for efficient and trouble-free operation of North Jetty.

C1330.1.2 The scope of work shall cover lighting design/calculation, manufacture, assembly, inspection and testing at works, packing/dispatch, transportation to site, receipt, unloading/ storage at site, erection, testing and commissioning of illumination system complete with all accessories in all respects, for all the buildings and outdoor area of North Jetty.

C1330.1.3 Emergency lights as per specification to be designed, supplied and installed by the contractor.

C1330.1.4 LED type aviation lights with 500VA UPS backup for 30mins to be considered in the High mast, Towers, Cranes and Elevated water tank.

C1330.2 Codes and Standards

C1330.2.1 The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant Indian Standards, IEC publications and other standards as listed, except where modified and/or supplemented by this specification. The design and testing shall follow the following standards.

IS: 10322 : Specification for Luminaires

IS: 9583 : Emergency lighting units.

IS/IEC 60079 -1 : Equipment Protection by Flameproof Enclosures "d"

IS: 2206 : Flame proof electric lighting fittings

IS: 732 : Electrical wiring installation (system voltage not exceeding 650 v

- IS: 12640 : Residual Circuit operated Circuit breakers.
 IS/IEC: 60947-1 : low-voltage switchgear and control gear.
 IS/IEC: 60898-1 : Miniature circuit breakers
 IS/IEC 60715 : Dimensions of low-voltage switchgear and control gear.
 IEC: 60309-1 : Plugs, socket-outlets and couplers for industrial purposes
 IS/IEC 60529 : Degrees of protection provided by enclosures (IP code)
 IS: 694 : PVC insulated cables for working voltages up to and including 1.1KV
 IS: 9537 : Conduits for electrical installation.
 IS: 3480 : Flexible steel conduits for electrical wiring.
 IS: 1239 : Mild steel tubes, tubular and other wrought steel fittings. (For size above 63mm dia. of rigid conduits
 IS: 14768 : Fittings for rigid steel conduits for electrical wiring.
 IS: 3837 : Accessories for rigid steel conduits for electrical wiring.
 IS: 14772 : Boxes for enclosures of electrical accessories.

C1330.3 Design and Construction

C1330.3.1 The lighting system includes 100% Normal AC lighting. Normal AC Lighting shall be energized from 3-phase, 4-wire, 415 V distribution board. During Electricity Board power supply failure, it will take 15-30 seconds to change over to Generator power supply and vice versa, considering the above it is proposed to provide UPS back up for essential lighting (Emergency lighting) in all the areas and essential equipment load such as server, Gates, Computer points etc. Illumination levels proposed at various places are listed below: Limiting values of glare index to be ensured as per area / location. Further design should ensure uniform lighting with no dark-spots and proper selection of fitting height etc.

C1330.3.2 The lighting circuits shall be designed based on operation & non-operation hour's requirements. The contractor shall ensure the same. Indoor & outdoor lights should be of LED energy efficient lights.

S. No.	Description	LUX Level	Type of Luminaries
1	Conference / Office / Training Room	500 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness

S. No.	Description	LUX Level	Type of Luminaries
			SMD LED
2	UPS / Electrical Substation	300 Lux	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink
3	Corridor	200 Lux	LED recess mounted fixture
4	Control Room	500 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness SMD LED
5	Server Room	300 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness SMD LED
6	Kitchen & Dining area	300 Lux	Indoor surface mounted LED Linear fitting
7	Toilet	200 Lux	Indoor surface mounted LED Linear fitting
8	Lift Lobby and stairways	200 Lux	LED recess mounted fixture
9	Locker room	100 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness

S. No.	Description	LUX Level	Type of Luminaries
			SMD LED
10	Workshop	150-300 Lux	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink
11	Utility Building/ Pump House	200 lux	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink
12	Access Walkway/Service Gallery	50 lux	Well Glass LED Light Fittings/ Flame proof LED light Fittings
13	Open landscape area/Near Main Berthing area/ Road Lighting	30 lux	Outdoor LED light fittings

C1330.3.3 For indoor areas, average lumen method shall be adopted to calculate luminance. Lighting level design shall include a Maintenance factor as follows to account for lamp lumen depreciation, luminaries' surface dirt and room surface dirt, etc.

- Air-conditioned/clean Room such as office rooms, Control and Switchgear room: 0.8
- Clean interiors such as office rooms, laboratories: 0.75
- Industrial areas with normal interiors such as workshops: 0.70
- Industrial areas with dusty interiors: 0.6
- Industrial areas with very dusty interiors: 0.5

C1330.3.4 Lighting level design shall also include the coefficient of utilization factor as calculated from table of reflectance provided by manufacturer for respective type of fixture.

C1330.3.5 For Outdoor flood lighting design, 'point by Point' method shall be adopted based on computer aided design package of the Contractor software. Uniformity in horizontal illuminance E_{min} / E_{avg} should be greater than 0.3.

C1330.4 Specific requirements

C1330.4.1 Switch control shall be provided for controlling lighting fixtures located indoor.

- C1330.4.2 Electric power to light fixtures located outdoors shall be switched with photoelectric controllers and timers (Digital type). Provision shall be made to bypass the photoelectric controller and timer (Digital type). For Road lighting, alternative lighting fixtures shall be fed from different phases.
- C1330.4.3 Load on each lighting circuit and single phase receptacle circuit shall be limited to about 1500 W and the number of luminaires connected to lighting circuit shall be limited to about fifteen (15).
- C1330.4.4 AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of $\pm 10\%$, frequency variation of $\pm 5\%$ and combined voltage and frequency variation of absolute sum of 10%.
- C1330.4.5 Power factor of lamp fixtures shall be not less than 0.90.
- C1330.4.6 Luminaires shall meet at least Electrical safety Class-I as per relevant IEC.
- C1330.5 Luminaires
- C1330.5.1 Luminaires shall be decorative type office building and industrial type in the case of service building. All the light fittings including outdoor shall be of LED light fittings of suitable wattage as per lighting design.
- C1330.6 High Mast Lighting
- Each Lighting Mast shall be 30M high, complete with the following accessories.
 - High mast shaft in two/three section, hot dip galvanized
 - Head frame, steel wire rope & double drum winch.
 - Galvanised Lantern carriage arrangement suitable for 12 nos. luminaires & its control gear boxes and Lightning finial.
 - LED Type outdoor luminaire to maintain lux level as per specification.
 - 20%,40%,40% Lighting control shall be provided for High mast
 - Control panel shall be made of GI or FRP enclosure.
 - Integral power tool installed inside base compartment for its operation.
 - Foundation bolts along with nuts, washers, anchor plate and templates
 - Control panel housing suitable control circuit for the operation of the mast, precision timer (digital type) for automatic On/Off control and required controls for the power tool motor. The control panel shall be of outdoor type preferably made by stainless steel with mounting frame etc.
 - Power & control cables and cabling accessories required for the installation.
 - Special tools & tackles
 - LED type aviation lights with UPS backup to be provided. UPS shall be kept in the Feeder pillar Box. Feeder pillar box shall be suitable to accommodate the UPS.

- Lightning arrester & Earthing system with Earth pit to be provided for each High mast.
 - 2 numbers of LED type aviation light in each High mast.
- C1330.6.1 The High mast shall be of continuously tapered, polygonal cross section, at least 20 sided, presenting a good and pleasing appearance and shall be based on proven design to give an assured performance, and reliable service. The entire fabricated mast shall be hot dip galvanized, internally and externally, having a uniform average thickness of at least 150 microns.
- C1330.6.2 An adequate door opening shall be provided at the base of the mast and the opening shall permit clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch.
- C1330.6.3 A fabricated Lantern Carriage shall be provided for fixing and holding the flood light fittings and control gearboxes. The lantern carriage shall be of steel tube construction, the tubes acting as conduits for wires, with holes fully protected by grommets.
- C1330.6.4 The winch shall be completely self-sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use, gravity activated PAWLS. Individual drum also shall be operated for fine adjustment of lantern carriage. The minimum-working load shall be not less than 750kg. The winch shall be self-lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers.
- C1330.6.5 A suitable, high-powered, electrically driven, internally mounted power tool with motor, with manual over ride shall be supplied for the raising and lowering of the lantern carriage for maintenance purposes. The power tool shall be of single speed, provided with a motor of the required rating. The power tool shall be supplied complete with suitable control.
- C1330.7 Lighting poles
- C1330.7.1 **General:** 5-meter height lighting poles to be provided in the reclamation area road lighting. Lighting pole shall be octagonal type, galvanized steel, supplied with base plate, foundation bolts, and necessary fixing-bracket for fixing the luminaire. Street lighting pole shall have integral junction box. All poles shall be provided with heavy square nuts on the anchor bolts under the pole base plate and hex nuts on the top. GI conduits shall be embedded in muff for incoming and outgoing cables. Height of poles shall be as per design calculation. Junction box shall be integral to the pole, supplied along with MCB and neutral link. Suitable wattage LED light fittings to be provided to meet the Lux level.
- C1330.7.2 **Design:** 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 BSEN 40-3:2000, EN-40-3-3.

- C1330.7.3 **Pole Shaft:** The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process. All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing foundation bolts. This 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 qualified MMAW process approved by Third Party Inspection agency.
- C1330.7.4 **Door opening:** The octagonal Poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing. The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.
- C1330.7.5 **Material:** Octagonal Poles HT Steel Conforming to grade S355JO. Base Plate Fe 410 conforming to IS 226 / IS 2062. Foundation Bolts EN.8 grade.
- C1330.7.6 **Welding:** The welding shall be carried out conforming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.
- C1330.7.7 **Pole sections:** The Octagonal Poles shall be in single section. There shall not be any circumferential weld joint.
- C1330.7.8 **Galvanization:** The poles shall be hot dip galvanised as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.
- C1330.7.9 **Fixing Type:** The Octagonal Poles shall be bolted on a pre-cast foundation with a set of foundation bolts for greater rigidity.
- C1330.7.10 **Manufacturing:** The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.
- C1330.7.11 **Pole Testing Facility:** The manufacturing unit shall have in-house pole testing facility for validation of structural design data. The pole testing facility shall conform to BS EN 40-3-2-2000 part 3-2.
- C1330.7.12 **Base Plate:** Suitable size base plate to be supplied along with the lighting pole.
- C1330.8 Service Gallery Lighting
- C1330.8.1 Flame proof light fittings/equipment shall be provided in the Service gallery.
- C1330.9 Kerb and Underdeck Lighting
- C1330.9.1 Outdoor type LED light fittings to be provided in the underdeck of the jetty and Kerb wall in the jetty.

- C1330.10 Emergency Lighting
- C1330.10.1 Emergency and exit lighting shall be provided through UPS for office building lighting only and rest of the other areas shall be provided with inbuilt battery backed light fitting.
- C1330.10.2 20% of the office light will get supply from UPS.
- C1330.10.3 Aviation lights in the High mast and other area shall be provided with 500VA UPS.
- C1330.11 Tests
- C1330.11.1 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. For the various bought out item test certificates from equipment Manufacturer shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards.
- C1330.12 Spares:
- C1330.12.1 The following spares shall be supplied without any additional cost.
- C1330.12.2 10% of each type light fitting to be provided as spare.

C1331 WIRING AND ACCESSORIES

- C1331.1 Scope of Work
- C1331.1.1 This chapter covers the detailed requirements of wiring work in conduit system and its accessories.
- C1331.1.2 The contractor shall supply, install data cables, data points as required in the Building.

C1332 WIRING SYSTEM

- C1332.1 Conduit Work
- C1332.1.1 All non- metallic conduit pipe and accessories shall be of suitable material complying with IS: 2509-1973 and IS: 3419-1989, IS: 9537(Part5)2000.
- C1332.2 General requirements
- C1332.2.1 All rigid conduit pipes shall be ISI marked. The wall thickness shall be not less than 1.4 mm thickness for conduit up to 20 mm dia, 1.6mm thickness for conduit for 25 mm dia, 1.9mm thickness for conduit for 32 mm dia and not less than 2 mm for conduits above 32 mm dia.
- C1332.2.2 The maximum number of PVC insulated cables conforming to IS: 694-1990 that can be drawn in one conduit is given size wise in Table I below, and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.
- C1332.2.3 No conduit less than 20 mm in diameter shall be used.
- C1332.2.4 Flexible conduits will only be permitted for interconnections between ceiling rose/junction box to light fixtures, conduit terminations in wall and interconnection between switchgear, DB's.

C1332.3 Conduit Accessories

C1332.3.1 The conduit wiring system shall be complete in all respects, including their accessories.

C1332.3.2 All conduit accessories shall be of solvent cement plastering type, and under no circumstances pin grip type of clamp grip type accessories shall be used.

C1332.3.3 Bends, couplers, etc. shall be solid type in recessed type of works and may be solid or inspection type as required.

C1332.3.4 Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 gauge) for conduits up to 25 mm dia. and not less than 0.9 mm (20 gauge) for larger diameter.

C1332.3.5 The minimum width and the thickness of girder clips used for fixing conduits to steel joists, and clamps shall be as per Table II below.

C1332.4 Outlets

C1332.4.1 The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 2 mm and in case of welded mild steel sheet boxes, the wall thickness shall not less than 1.2 mm (18 gauge) for boxes up to a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection.

C1332.4.2 An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

C1332.4.3 Clear depth of the box shall not be less than 60 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

C1332.4.4 The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Employer.

C1332.4.5 Except where otherwise stated, 3 mm thick phenolic laminated sheets as per clause shall be fixed on the front with brass screws, or cadmium plated iron screws as approved by the Employer.

Table-I: Maximum number of PVC insulated 650/1100V grade Aluminium/Copper conductor cable conforming to IS: 694-1990 in rigid PVC/Steel conduit

Conductor area, mm ²	20 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1/1.5	5	4	10	8	18	12	-	-	-	-	-	-
2.5	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
8	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

Note:

- The above table shows the maximum size of conduits for a simultaneous drawing of cables.
- The columns headed S apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed B applies to runs of conduit which deflect from straight by an angle of more than 15 degrees.
- Conduit sizes are the nominal external diameters.

Table-II: Sizes of Girder Clips Clamps

Size of conduit	Width	Thickness
20 mm	19 mm	0.9 mm (20 SWG)
25 mm	19 mm	0.9 mm (20 SWG)
32 mm & above	25 mm	1.2 mm (18 SWG)

C1333 INSTALLATION OF CONDUIT

C1333.1 Conduit Joints

C1333.1.1 The erection of conduits of each circuit shall be completed before the cables are drawn in. All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work.

C1333.1.2 Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes. The Employer, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

C1333.2 Bends in conduit

C1333.2.1 All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used. Radius of bends in conduit pipes shall not be less than 7.5 cm.

C1333.2.2 No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet. Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

C1333.3 Outlets

C1333.3.1 All switches, plugs, fan regulators etc. shall be fitted in flush pattern. The fan regulators can be mounted on the switch box covers, if so directed by the Employer.

C1333.3.2 After installation, all accessible surfaces of metallic accessories shall be painted. Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a closer distance from the centre of such fittings. Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.

C1333.4 Fixing of conduits

C1333.4.1 Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Employer. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used. If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

C1333.4.2 The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired.

C1333.4.3 In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit. In case of exposed brick / rubber masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

- C1333.4.4 The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart or by any other approved means of fixing. All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.
- C1333.4.5 The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.
- C1333.4.6 Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors. Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.
- C1333.4.7 Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary. These shall be mounted flush with the wall or ceiling concrete. Suitable ventilating holes shall be provided in the inspection box covers.
- C1333.5 Wiring
- C1333.5.1 Wires shall be Flame Retardant Low Smoke grade(FRLSH), PVC insulated with bright annealed electrolytic grade (99.9% pure) copper stranded for uniformity of resistance, dimension and flexibility and suitable up to 660V grade wires for single phase circuits and 1100 V grade for 3 phase circuits as per IS 694/1990 amended up to date.
- C1333.6 Colour coded as below:
- | | | |
|-----------|---|--------|
| Phase - R | - | Red |
| Phase - Y | - | Yellow |
| Phase - B | - | Blue |
| Neutral | - | Black |
| Earth | - | Green |
- C1333.7 Wiring in Conduit
- The wiring in conduit shall comply the following:
- | | | |
|-------------------------------|---|---------------------|
| Wire sizes | - | Copper conductor |
| Light point / Sub main wiring | - | 1.5 sq.mm |
| Light Circuit Point | - | 2.5 sq.mm |
| Power points | - | 4.0 sq.mm |
| Machinery | - | As per requirements |
- C1333.7.1 Jointing of wires is not permissible, however looping may be done from point (same circuit) or using a terminal strip in junction box where site condition warrants, prior permission from Employer shall be obtained.
- C1333.7.2 Voltage drop in the cable shall be limited as follows,

- Lighting panel to lighting fixtures :3%
- Switchbox to lighting fixtures:1.5%
- Lighting panel to socket:3%
- Lighting panel to switch box:1.5%
- For outdoor lighting & road lighting, XLPE insulated, PVC inner sheathed, armoured, FRLSH PVC outer sheathed cables shall be provided.
- Wiring for lighting circuits of Normal AC system, Emergency AC System and DC system shall run in separate conduits.

C1334 WIRING ACCESSORIES

C1334.1 Control switches for points

C1334.1.1 Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

C1334.1.2 Combined switch cum socket shall not be permitted.

C1334.2 Socket outlets

C1334.2.1 The 5A/6A socket outlet shall be 3 pin socket outlet with 5A/6A switch, where so specified in the tender documents.

C1334.2.2 The power point outlet shall be 15A/5A or 16A/6A 6 pin socket outlet with 15A/16A switch, where so specified in the tender documents.

C1334.3 Data Points

C1334.3.1 Data points to be provided in the Buildings in necessary places to take data to the workstations. Conduits, data cables etc. to be supplied and installed in complete.

C1334.4 Switch box covers

C1334.4.1 Modular type switches/ sockets suitable outer and inner cover plates as specified shall be provided over the standard box as recommended by the manufacturers of modular type switch/ sockets and no separate sheet cover is required to be provided.

C1334.5 Ceiling rose

C1334.5.1 Ceiling rose shall be of 3-plate type.

C1334.5.2 A ceiling rose shall not be used on circuit the voltage of which normally exceeds 250V.

C1334.5.3 Only one flexible cord shall be connected to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants.

C1334.5.4 A ceiling rose shall not embody fuse terminal as an integral part of it.

C1334.5.5 Where ever ceiling roses are not used the wires are to be terminated in good quality connectors of 6A capacity inside PVC junction boxes.

- C1334.5.6 All the junction boxes are to be covered with good quality round cover plate of approved colour.
- C1334.6 Lamp holders
- C1334.6.1 The standard constructional feature of manufacturers (ISI approved) of lamp holders is acceptable.
- C1334.6.2 The bottom of wiring devices shall be mounted the following distances above the finished floor.

Wiring Devices	Location	Distance aboveFloor
Receptacles	Offices and finished areas	500 mm
Receptacles	All other locations	900 mm
Switches	All locations	1500 mm
Ceiling fan control	All locations	1500 mm
Ceiling fans	All locations	2500 to 3000 mm

- C1334.7 Ceiling Fans
- C1334.7.1 Ceiling fans shall be of reputed make, BIS approved, 1200 mm sweep complete with copper wound, class E insulated motor, and three nos. balanced blades, suspension rod, canopy and other accessories conforming to applicable IS. Ceiling fans shall be supplied with a wall mounted controller to turn the fan on and off and to vary the fan speed from 0 to 100%. Controller shall be Electronic type free from humming noise. Pedestal fans shall be of reputed make, BIS approved, 500mm sweep, complete with aluminium blades, cast iron base, copper wound, class E insulated motor, support column, control switch and other accessories conforming to applicable IS.
- C1334.8 PIR occupancy sensors
- C1334.8.1 PIR occupancy sensor shall be used to control the lights in the common use areas such as toilet, dining hall, canteen etc. The sensor shall have advanced detection by passive infrared (PIR) technology along with Sensitivity level adjustments which is sensitive to the heat emitted by the human body as well as daylight sensor which shall have communicating with the controller for measuring daylight and controlling lights in the associated zone for switch on/off.
- C1334.8.2 Lux reading of the sensor should be measurable and readable on the system if the sensor is networkable. In order to trigger the sensor, the source of heat must move from one zone of sensing to another. Non-moving hot objects will not cause the lights to turn ON (like incandescent lights). Fast, Simple Installation: Easy base mount, three wire connection (low voltage) and twist-and-lock detector attachment. Non-Volatile Memory: Learned and adjusted settings saved in protected memory are not lost during power outages.

- C1334.8.3 Timer (Digital) setting feature the sensor has Adjustable off delay timing 10 sec–30 min which can be programmed & changed using IR programming device with auto exit programming. The sensor has inbuilt IR receiver to be used in conjunction with IR Remote Control for manual override.
- C1334.8.4 PIR Masking: Pre-scored masking disks are provided with the device for fine tuning the field-of-view. High Motion Sensitivity: Large lens area and multi-element lens design gives excellent range and sensitivity. Ambient Light Mode: Integrated photocell prevents lights turning on under adequate ambient light. Auto-Adapting Mode: Internal microprocessor continually analyses and adjusts the sensitivity and time delay. Walk-Through Mode: Provides increased energy savings by decreasing the time delay to 2.5min when someone momentarily walks through the monitored space. The sensor shall have the provision for wall mounting/ Ceiling mounting facility as per the site requirement.
- C1334.8.5 Sensor shall include mounting hardware, decorator wall plate cover and screws to mount cover. Wall plate cover colour shall match the sensor. With Detection speed: 1.0m/s & Lux level of 10-2000lux (illumination of non-reflective surface in sensor's field of view)
- C1334.9 Distribution and Wiring
- C1334.9.1 The main distribution board and branch distribution board shall be controlled or provided with miniature circuit breaker (MCB)/Residual Current Circuit Breaker (RCCB)/MCB isolator/MCCB of specified rating on the phase or live conductor or combined phase and neutral control gear for incoming and out-going
- C1334.9.2 Distribution of sub-main and circuits shall be as per final approved single line diagram. The balancing of circuits in three wire or poly phase installations shall be arranged to the satisfaction of the Employer. Unless and otherwise specified in the tender documents, wiring shall be done only by the "Looping system". Phase or live conductors shall be looped at the switch boxes and neutral conductors at the point outlets. Lights, fans and call bells shall be wired in the 'lighting' circuits. 15A/16A socket outlets and other power outlets shall be wired in the 'Power' circuits. 5A/6A socket outlets shall be wired in the 'lighting circuits'. The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear. Surface wiring shall run, as far as possible, along the walls and ceiling so as to be easily accessible for inspection.
- C1334.9.3 In no case, the open wiring shall be run above the false ceiling without the approval of Employer. In all types of wiring, due consideration shall be given for neatness, good appearance and safety.

- C1334.9.4 Where a wall pipe passes outside a building so as to be exposed to weather, the outer end shall be bell mouthed and turned downwards and properly bushed on the open end. All floor openings for carrying any wiring shall be suitably sealed after installation. No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and /or protective conductors in wiring shall be permitted. There shall be no joints in the through-runs of cables. If the length of final circuit or sub main is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes. Termination of multi-stranded conductors shall be done using suitable crimping type thimbles.
- C1334.10 Fixing switch boxes and accessories
- C1334.10.1 Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified. To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6mm/1.2mm (16/18 SWG) shall be provided along with the laying of the recessed conduit. Cables carrying Direct Current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit. Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit. In case of three phase loads, separate conduits shall be run from the distribution boards to the load points, or outlets as the case may be. The conduit pipe shall be fixed by means of staples, or by means of non-metallic saddles, placed at not more than 60 cm apart, or shall be fixed by any other approved means of fixing. At either side of the bends, saddles/staples shall be fixed at a distance of 15 cm from the centre of the bends.
- C1334.11 Special Note
- C1334.11.1 Wherever spare conduits are laid GI fish wire of 1.6mm/1.2mm (16/18 SWG) shall be laid along with the conduit to facilitate easy pulling of wires in future without any extra cost.
- C1334.11.2 For points coming in false ceiling, as far as possible, wiring shall be terminated in a junction box/connector very close to the points.
- C1334.11.3 All the civil works such as chipping, plastering, making good all damages connected with the fixing of switch boxes are included in the scope.
- C1334.11.4 Unless otherwise specified wiring shall be terminated to either ceiling rose, connector, lamp holder or switch
- C1334.11.5 MCB Distribution Boards (MCB DBS) And Accessories
- C1334.12 Scope of Work
- C1334.12.1 This chapter covers the detailed requirements of MCB Distribution Boxes and its accessories.

C1334.13 MCB Distribution Boards (MCB DBs)

C1334.13.1 All SPN & TPN DBs shall be suitable for flush mounting with double door and to be provided with inbuilt additional compartment for looping of loose wires/adaptor boxes for entry of armoured cables with IP 42/43 category of protection and conform to IS: 8623.

C1334.14 Material

C1334.14.1 The DBs are to be fabricated out of CRCA sheets suitable for all weather operation. The current carrying parts are to be made of electrolytic grade copper and are to be rated for the duty intended. The DBs should have knock out holes at the bottom, and detachable plate with knock out holes at the top.

C1334.15 Painting

C1334.15.1 The DBs are to be subjected to seven tank phosphatising processes and to be powder coated ensuring rust prevention and scratch resistant.

C1334.16 Accessories

C1334.16.1 Following accessories are to be provided: -

- Copper bus bars of rated current capacity per phase.
- Special brass terminals to ensure perfect connections of incoming cable with the bus bars.
- Brass neutral bars three numbers, one for each phase, isolated and insulated from the enclosures with suitable cross sectional area.
- Earth bars for firm earthing and for facilitating individual earthings for each outgoing terminal.
- Sufficient number of blanking plates.
- Provision for accommodating four pole MCB and RCCB as incomer.

C1334.17 Miniature Circuit Breakers (MCB)

C1334.17.1 All MCBs should conform to IS:8828, IEC:60898-1(2002) and rated for 10kA category of short circuit duty and tested for breaking capacity up to 10 kA. C curve type for inductive loads and D curve type for UPS loads. MCBs shall be suitable for use in frequency range 50 Hz to 60 Hz and shall accommodate AC/DC supply according to requirements. It should have inverse time overload and short circuit tripping mechanism with trip free operation and toggle shall give positive contact indication. Arc chutes should be provided for effective quenching of arc during operations and fault conditions. Terminals should be provided with proper shrouding arrangement. Silver cadmium Oxide tipped contacts should be provided in MCBs. Pressure clamp terminals for users up to 4 sq.mm and bolted lugs for higher rating should be provided. Multipole MCBs should be provided with common operating handle and integral tripping. The MCBs shall be of IP 20 degree of protection. The power loss per pole shall be in accordance with IS: 8828 and shall be furnished by the manufacturer.

- C1334.17.2 MCB casing shall be made of self-extinguishing tropicalized material. It shall be suitable for mounting on 35 mm DIN rail/surface mounting. Line supply may be connected to either top or bottom terminals i.e. there shall be no line load restriction. Degree of protection, when the MCB is flush mounted, shall be IP 40. MCB shall be supplied with clamping terminals fully open. Contact closing shall be independent of the speed of the operator. The MCB shall be capable of being used as incomer circuit breaker and shall be suitable for use as an isolator. In case of multiple MCBs in a single location (DB), it shall be possible to remove MCB without having to disturb other MCBs in the vicinity. All MCB's shall be capable of carrying 35sq.mm. Cable termination. Both the upper and lower terminals of MCB's shall be bi-connect type, i.e., capable of connecting bus bar and cable at both the end.
- C1334.17.3 Residual Current Circuit Breaker with Overload protection (RCCB)
- C1334.17.4 Residual Current Circuit Breakers shall be provided complete protection against Earth leakage faults. RCCB should conform to IS: 12640-2008, IEC 61008-1.
- C1334.17.5 The RCCB shall have threshold sensitivities (non-user adjustable) of 30mA, 100 mA & 300 mA with inbuilt time delay of 200 ms for discrimination with downstream RCCB. The short circuit withstand capacity of the RCCB shall not be less than 6 kA. It shall be operationally independent of line voltage. The breaker should be maintenance free. The breaker should be capable of detecting earth leakage currents and disconnecting the faulty lines. The RCCB should be unaffected by the DC pulsated components, present if any in the circuit, and should not give nuisance tripping. A test device should be incorporated to check the integrity of the system and tripping mechanism. Terminals should ensure easy termination of cables and should provide covers to shield incoming and outgoing terminals with IP 20 degree of protection. The breaker should be suitable for DIN rail mounting. All RCCB's shall be capable of carrying 35sq.mm. Cable termination. Both the upper and lower terminals of RCCB's shall be bi-connect type, i.e., capable of connecting bus bar and cable at both the end.

C1335 CABLE TRAYS AND ACCESSORIES

- C1335.1 Scope of Work
- C1335.1.1 The scope covers the manufacture, supply, inspection, testing and commissioning of G.I. pre-fabricated Heavy Duty cable trays, GI Ladder cable trays and accessories.20% spare capacity to be considered in each cable tray.
- C1335.2 Standards
- C1335.2.1 The M.S. materials used in the manufacturer of cable trays and accessories shall conform to the requirements of ASTM – A36 / IS 2062 and the Hot Dip Galvanising shall be as per BS-729 or ASTM – A – 123 or IS – 2629.
- C1335.3 Introduction
- C1335.3.1 This specification covers the requirements of cable trays, support structures, Cable laying etc.

C1335.4 General Requirements

- C1335.4.1 While finalizing Cable routing layouts, consideration shall be given to the requirements of Safety, Reliability and Convenience of cable laying and termination.
- C1335.4.2 Where duplicate drives/auxiliaries are provided for reliability, cable routing shall be segregated to the extent practically possible.
- C1335.4.3 In cable trenches, distance between bottoms most tier and bottom of trench shall be 150 mm and clearance from top most tray to top of trench cover shall be 400 mm. Distance between two tiers shall be minimum 250 mm.
- C1335.4.4 PCC flooring of built-up trenches shall be sloped in longitudinal and also in transverse direction for effective drainage system. Other than cable vault & cable trenches, Cable trays shall be laid in vertical formation to avoid dust accumulation in areas.
- C1335.4.5 In cable spreader room a clear access passage of at least 800 mm wide shall be provided along the cable ways. Wherever passage is through cable routes, a clear height of not less than 2.0 M shall be provided.
- C1335.4.6 Cables should not be laid directly in the trench floor. Cables trenches should be provided with strong & effective covers with water & fire proof sealing arrangement at trench entry & exit points.
- C1335.4.7 Cables of different voltages shall be laid in separate racks. Minimum distance of 250 mm shall be maintained along the routes between various types of cables. In case of horizontal formation, the highest voltage cables shall be laid in the top most position in the tray stack followed by other grades as follows in the descending order.
- 11 kV Power cables (Top Tier)
 - 1.1kV Power cables (Below HT Tier)
 - Electrical Control Cables (Below LT Tier)
 - Instrumentation/Signal cables (Bottom most tier)
- C1335.4.8 On cable trays all the multicore power cables can be laid in touching formation. Single core cables shall be laid in trefoil formation with the spacing equal to twice the diameter of the cable.
- C1335.4.9 Control cables shall be laid in not more than two layers.
- C1335.4.10 Cables shall be terminated using double compression cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass. Cable lugs for power and control cables shall be tinned copper solderless crimping type conforming to IS 8309. 11 kV cable terminations shall preferably be of heat shrinkable type kits.
- C1335.4.11 Power & Control cables shall be laid on ladder type trays. Instrumentation & Signal cables shall be laid on perforated type trays. Cable trays shall be of galvanized steel. Cable trays shall be supported at an interval of 1500 mm approximately. Vertical runs shall be supported at an interval of 1000 mm approximately. Cable tray support system shall be of site fabricated, welded and painted steel supports.

- C1335.4.12 Cable tray support system shall consist of ISMC channel as vertical support & ISA as horizontal arm. Horizontal arm is welded to the vertical support MS channel.
- C1335.4.13 Fire barriers/ Fire stops shall be provided for all fire rated wall and floor penetrations and for all direct cable entries into electrical Switchgear / Panels from Cable Vault.
- C1335.4.14 Fire barriers/ Fire stops shall provide a fire endurance rating of at least 2 hours. The fire sealing material shall be non-hygroscopic, mechanically steady, non-toxic and physically & chemically stable under fire conditions. Fire barriers/ Fire stops shall be either of the following methods:
- Panel sealing method comprising Encasing Panels, Cavity fill material & Sealant
 - Mortar sealing method comprising Mixing Mortar curing with water.

C1336 DESIGN AND CONSTRUCTION

C1336.1 Cable trays, Fittings & Accessories

C1336.1.1 Cable trays shall be ladder/perforated type as specified prefabricated (FACTORY MADE) made out of hot/cold rolled mild steel sheets, complete with matching fittings (like elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, Tray cover etc.) and hardware (like bolts, nuts, washers, GI strap, hook etc.) as required. All the items (including hardware) shall be hot dip galvanized. Thickness of galvanizing shall be not less than 610grams/sqm. The size of the trays shall be selected on the basis of maximum 40% fill criteria. Fabrication/cutting/welding of cable tray at site is not permitted.

C1336.1.2 Cable trays shall be standard width of 150mm, 300mm, 450mm & 600mm and standard lengths of 2.5 m or more. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2mm. Rung spacing shall be 250mm maximum. The thickness of side coupler plates shall be minimum 2.5mm and of tray covers shall be minimum 1.6mm. Cable Trough shall be required for branching out few cables from main cable route. These shall be fabricated of mild steel sheets of minimum thickness 2mm and shall be hot dipped galvanized. Troughs shall be of standard width of 50mm & 75mm and 25mm height.

C1336.2 Conduits/Pipes, Fittings & Accessories

C1336.2.1 Conduits/pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.). The size of the conduit/pipe shall be selected on the basis of maximum 40% fill criteria.

C1336.2.2 Hume pipes shall be of reinforced concrete conforming to class NP3 for road crossings as per IS: 458. GI pipes shall be of medium duty as per IS: 1239.

- C1336.2.3 Rigid steel conduits conforming to IS: 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside. Fittings and accessories shall also be hot dip galvanized.
- C1336.2.4 Flexible conduits where required, near equipment terminations, shall be made with bright, cold rolled, annealed and electro-galvanized mild steel strips. Flexible conduits shall be supplied with suitable end coupler nipple and check nut. In corrosive areas, epoxy coated conduits shall be provided.
- C1336.3 Clamps
- C1336.3.1 Trefoil clamps for single core cables shall be pressure die cast aluminium or fibre glass or nylon and shall include necessary fixing accessories like GI nuts, bolts, washers etc. Trefoil clamps shall have adequate mechanical withstand capability in case of a fault and shall be tested and proven type. For clamping the multicore cables self-locking, de-interlocking type nylon clamps shall be used.
- C1336.4 Cabling Installation
- C1336.4.1 The work shall be carried out in the best workman like manner in conformity with relevant specifications / code of practices of the Bureau of Indian Standards. In addition, work shall also conform to the requirements of latest editions / amendments of the following: -
- Indian Electricity Act and rules framed thereunder.
 - Fire Insurance Regulations
 - Regulations laid by the office of the Chief Electrical Inspector to Government/CEA
 - Any other regulations laid down by the local authorities.
- C1336.4.2 Support system shall be so designed that it is able to withstand weight of the cable trays, Weight of the cables (75 Kg/meter run of each cable tray), Concentrated load of 75 Kg between every support span without any permanent deflection. Factors of safety of at least 1.5 shall be considered.
- C1336.4.3 Cable tray mounting structure shall be welded/ bolted to the plate inserts or to steel structure and the type of welding shall be of fillet type of at least 6mm size.
- C1336.4.4 All cable way sections shall have identification, designations as per cable way layout drawings and painted/stencilled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stencilled with identification numbers at every floor.
- C1336.4.5 Tray covers shall be provided for overhead cable trays on top most tier. The cable risers or vertical raceways shall also be covered by cable tray covers up to 1.5 meters from respective floor for mechanical protection. The sheet cover shall be of removable type.

C1336.5 Inspection & Test

C1336.5.1 The vendor shall carryout all the tests & relevant inspection & test reports should be submitted.

- The inspection /tests shall include the following:
- Verification of dimensions.
- Visual inspection for quality of manufacture, particularly smoothness of surface on both inside and outside.
- Deflection load test.
- Quality of fabrication.
- Galvanizing test.

C1336.5.2 Materials found not complying with the requirements of this specification will be rejected and shall be replaced by vendor at his own cost.

C1336.6 Data and Information:

C1336.6.1 Seller/contractor/vender shall furnish the following technical data along with the quotation/offer.

- Loading characteristics - permissible loading data for various sizes of cable trays. Supporting spans to be considered as 2M for both Ladder cable trays and perforated cable trays. Necessary test certificate shall be furnished.
- Dimensional G.A. drawings, indicating all components of cable tray.
- Method of Testing and corresponding standards.
- Installation Guidelines, such as fixing of cable trays on structural supports, clamping facility for the cables on the rungs of cable trays, etc.

C1337 LIGHTNING PROTECTION

C1337.1 Scope

C1337.1.1 This covers the detailed requirements of installation of Lightning Arresters, lightning conductor system for protection of buildings against lightning as per the scope of work defined in various sections of this specification. The system shall conform to NFC 17-102:2011/IEC 62-305:2006. After award of work the contractor shall design & prepare a scheme for lightning protection and get the same approved by the consultant. Soil resistivity test also to be carried out by the contractor after award of contract without any additional cost and the value obtained on the test to be used for the design of Lightning protection system.

C1337.1.2 Lightning arresters to be provided in the High mast, Crane, Water tank also.

C1337.2 Design

C1337.2.1 Lightning protection will be provided to all buildings and high mast and high structures in the North jetty. Suitable number of the earth pits shall be envisaged for the lightning protection.

- C1337.2.2 The acceptable resistance of ground rods shall not exceed 0.8 ohms under normal dry conditions.
- C1337.3 Components
- C1337.3.1 The principal components of the lightning protective system shall be as under:
- Lightning Arresters.
 - Air terminations.
 - Down conductors. (Structural Reinforcement in external columns)
 - Joint and bonds.
 - Testing joints.
 - Earth terminations.
 - Earth Electrodes.
- C1337.4 Materials
- C1337.4.1 The materials of air terminations, down conductors, earth termination etc., of the protective system shall be reliably resistant to corrosion or be adequately protected against corrosion.
- The material shall be of the following, as specified. All air terminations and down conductors shall be as per the schedule of quantities.
 - The recommended shape and minimum sizes of conductors for use above and ground shall be conforming to relevant I.S. specifications.
- C1337.5 Air Terminations (on the buildings)
- C1337.5.1 Air termination networks may consist of vertical or horizontal conductors, or combinations of both. For the purpose of lightning protection, the vertical and horizontal conductors shall be considered equivalent and the use of pointed air terminations, or vertical finial is, therefore, not regarded as essential.
- C1337.5.2 A vertical air termination, where provided, need not have more than one point, and shall project at least 30cm, above the object, salient point or network on which it is fixed.
- C1337.5.3 For a flat roof, horizontal air termination along the outer perimeter of the, roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed. No part of the roof should be more than 9m from the nearest horizontal protective conductor.
- C1337.5.4 Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and, where necessary, over flat surfaces, in such a way as to join each air termination to the rest, and should themselves form a closed network.
- C1337.5.5 All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth should be bonded and form a part of the air termination network.

- C1337.5.6 If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be bonded to the down conductors of the taller portions, in addition to their own down conductors.
- C1337.5.7 For air terminations in the buildings, GI strip, hot dipped galvanised of size 20x3 mm shall be used.
- C1337.6 Down Conductor (on buildings)
- C1337.6.1 A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.
- C1337.6.2 The walls of light wells may be used for fixing down conductors, but lift shafts should not be used for this purpose.
- C1337.6.3 Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors, but cannot replace them, such connections should have disconnecting joints.
- C1337.6.4 In deciding on the routing of the down conductor its accessibility for inspection, testing and maintenance should be taken into consideration.
- C1337.6.5 Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons standing under the overhang. In such cases, the down conductor may be housed in an air space provided by a non-metallic and non-combustible internal duct and taken straight down to the ground.
- C1337.6.6 Any suitable covered recess, not smaller than 76mm x 13mm, or any suitable vertical service duct running the full height of the building may be used for this purpose, provided it does not contain an un-armoured or a non-metal sheathed cable.
- C1337.6.7 In cases where an unrestricted duct is used, seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.
- C1337.6.8 The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the buildings.
- C1337.6.9 For down conductors in the buildings, 8mm Aluminium round conductor shall be used.
- C1337.6.10 Down conductors. (Structural Reinforcement in external columns):
- C1337.6.11 A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.
- C1337.6.12 Structural steel in the external column shall be used as down conductor as per IEC 62305.

- C1337.6.13 Lightning protection system from the roof shall be welded to the column insert plates provided at the top end of the external columns.
- C1337.6.14 The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the building. The horizontal conductors above the roof shall be fixed by using drill free mechanism by using suitable clamps rigidly. Drilling above the roof should not allowed and the fixing clamps should be designed in such a way that the connection should be strong. The vertical conductors should be fixed in such a manner it should not exposed in visible area and does not spoil the architectural or aesthetic beauty of the building.
- C1337.6.15 The contractor shall prepare & submit the drawings and get them approved from the Employer before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipment's/materials as per requirement. The drawing consists lay out drawings of the horizontal and vertical conductors including its support details, sections, connections etc.

C1338 INSTALLATION

C1338.1 General

- C1338.1.1 The entire lightning protective system should be mechanically strong to withstand the mechanical forces produced in the event of a lightning strike.
- C1338.1.2 Conductors shall be securely attached to the building, or other object to be protected by fasteners, which shall be substantial in construction, not subject to breakage, and shall be of galvanized steel or other suitable materials, with suitable precautions to avoid corrosion.
- C1338.1.3 The lightning finial in the high mast shall be connected with the high mast earthing system which shall be finally get connected with the earthing pit designated for mast lighting protection
- C1338.1.4 The lightning conductors shall be secured not more than 1.2mtrs apart for horizontal run (in buildings), and 1m for vertical run.
- C1338.1.5 All air terminals in the buildings shall be effectively secured against overturning either by attachment to the object to be protected, or by means of substantial bracings and fixings which shall be permanently and rigidly attached to the building. The method and nature of the fixings should be simple, solid and permanent, due attention being given to the climatic conditions and possible corrosion.

C1338.2 Down Conductors

- C1338.2.1 The down conductor system in the buildings must, where practicable, be directly routed from the air termination to the earth termination network, and as far as possible, be symmetrically placed around the outside walls of the structure starting from the corners. In all cases consideration to side flashing must always be given.

C1338.2.2 Practical reasons may not sometimes allow the most direct route to be followed. For the roof edges only sharp bends are permitted. However, since most of the buildings have roofs with rain water gutters at their edges a loop around this gutter is inevitable and a direct path is practically not possible. However, for all such loops the length of the conductor along the loop shall not exceed eight times the distance between the two ends of the loop.

C1338.2.3 When large re-entrant loops as defined above cannot be avoided, such as in the case of some cornices or parapets, the conductors should be arranged in such a way that the distance across the open side of a loop complies with the requirement indicated above. Alternatively, such cornices or parapets should be provided with holes through which the conductor can pass freely.

C1338.3 Bonding to prevent side flashing

C1338.3.1 Any metal in, or forming a part of the structure, or any building services having metallic parts which are in contact with the general mass of the earth, should be either isolated from, or bonded to the down conductor. This also applies to all exposed large metal items having any dimension greater than 2m whether connected to the earth or not.

C1339 JOINTS AND BONDS

C1339.1 Joints

- The lightning protective system should have as few joints as possible.
- Joints should be mechanically and electrically effective, i.e. clamped, screwed, bolted, crimped, riveted or welded.
- With overlapping joints, the length of the overlap should not be less than 20mm for all types of conductors.
- Contact surfaces should first be cleaned, and then inhibited from oxidation with a suitable non-corrosive compound.
- Joints of dissimilar metals should be protected against corrosion or erosion from the elements, or the environment and should present an adequate contact area.

C1339.2 Bonds

- Bonds have to join a variety of metallic parts of different shapes and composition, and cannot therefore be of a standard form.
- To avoid the problem of corrosion and careful attention must be given to the metals involved, i.e. The metal from which the bond is made and those of the items being bonded.
- The bond must be mechanically and electrically effective, and protected from corrosion in and erosion by the operating environment.
- External metal on, or forming part of a structure, may have to discharge the full lightning current, and its bond to the lightning protective system shall have a cross sectional area not less than that employed for the main conductors.

- Structures supporting overhead electric supply, telephone and other lines must not be bonded to a lightning protective system without the permission of the Employer.
- Gas pipe in no case shall be bonded to the lightning protective earth termination system.

C1339.3 Test Joints

C1339.3.1 Each down conductor shall be provided with a test joint in such a position that, while not inviting unauthorized interference, it is convenient for use when testing.

C1339.4 Earth Termination Network

C1339.4.1 An earth station comprising one earth electrodes as required shall be connected to each down conductor coming from high mast or building.

C1339.4.2 The whole of the lightning protective system, including, any ring earth, should have a combined resistance to earth not exceeding 10 ohms without taking account of any bonding.

C1339.4.3 If the value obtained for the whole of the lightning protection system exceeds 10 ohms, a reduction shall be achieved by extending or adding to the electrodes or by interconnecting the individual earth terminations of the down conductors by a conductor installed below ground, sometimes referred to as a ring conductor. Buried ring conductors laid in this manner are considered to be an integral part of the earth termination network, and should be taken into account when assessing the overall value of resistance to earth of the installation.

C1339.4.4 Earth electrodes should be capable of being isolated and reference earth point should be provided for testing purposes.

C1339.5 Earth pits

C1339.5.1 Chemical/mineral earthing shall be provided as per IEC 62305 part3, IEC 60364, IEC 62561 part 2, IS 3043, IS 2309, UL 467 & UL 96 standards.

C1339.5.2 Maintenance free earthing arrangement to carry fault current with 250 microns molecularly copper bonded solid high carbon steel rod of diameter 20mm and minimum length 3 Meters (1 meters*3) tested for 10/350 micro second wave form, stainless steel connectors and fasteners for connecting electrode with earthing conductor/strip, etc., with earth enhancing mineral compound is recommended as per above mentioned standards. The electrode shall be hand driven or hammered in to earth for soft soil and drilling for rocky and hard soil.

C1339.5.3 Earthing System comprises of molecularly bonded copper of 99.9% purity on low carbon steel of 3m length (1m (219 20 CU) x 3 nos), having a diameter of 20mm with copper coating thickness of 250 microns with self-coupling bore and peg arrangement (without the need for external coupler) with fault current withstand capability of 15 KA rms value for 1 second. For obtaining desired length, the number of rods shall be increased and is provided with Universal Clamp (2730 20 VA) made of SS 304 for clamping the cable/flat conductor to the rod. Impact point (219 20 IP) on the bottom rod for easy insertion.

C1339.5.4 Earth enhancing mineral compound (ECS PB 12.5) is used for improving the soil conductivity. Earth enhancing mineral compound shall be so designed and constructed that in normal use their performance is reliable and without danger to persons and the surroundings. The material shall be mineral inert to sub soil and shall not pollute the environment. It shall provide a stable environment in terms of physical and chemical properties and exhibit low resistivity. It shall not be corrosive to the earth electrode itself. The material should have a resistivity less than 50 Ohm meter. It should be free from hazardous substances. The mineral compound is required to have minimum 12.5 Kg of the total composite.

C1340 EARTHING SYSTEM

C1340.1 Scope of Work

C1340.1.1 This section covers the design, supply, erection and commissioning of earthing arrangement for the whole of the plant as defined in various sections of this specification.

C1340.1.2 Rail Earthing: Rail to be interconnected at 50mtr interval through 2 runs of suitable size earth flats which shall run inside the jetty screed. 2 runs of earth flats shall run parallel to the rails and both end of the rail will be connected to the plant earthing system.

C1340.1.3 Earthing shall be through hot dip GI strip and GI earth pit as detailed in the subsequent sections. All earth pits shall be back filled with Lores-GEM (ground enhancement material) or equivalent make mentioned on approved list.

C1340.1.4 After award of work, the contractor shall design & prepare a scheme for Earthing protection system and get the same approved by the consultant. Soil resistivity test also to be carried out by the contractor after award of contract without any additional cost and the value obtained on the test to be used for the design of Earthing protection system.

C1340.2 Design

C1340.2.1 Earthing system as specified shall be carried out as per best Engineering practices.

C1340.2.2 The earth grid design shall be done by the contractor as per IS3043 and submitted to the consultant for approval. The soil resistivity measurement shall also be done by the contractor as per the relevant sections of the IS3043.

C1340.3 General Requirements

C1340.3.1 Building shall be provided with a complete earthing system, comprising of earth pits and buried earthing strips. Earth electrodes shall be provided for each electrical equipment and connected together to form earth grid to achieve the desired value.

C1340.3.2 After the award of contract, the contractor shall conduct soil resistivity test, and design the earthing system as per IEEE80 (Latest), IS3043 and submit the same for the approval of the consultant.

C1340.3.3 Dedicated earthing system to be provided by the contractor for the Electronic earthing.

- C1340.4 Earth resistivity testing
- C1340.4.1 The successful bidder shall carry out the earth resistivity measurement of the complete site as per IS3043. No additional charges shall be paid for the same.
- C1340.5 Methodology for Earthing
- C1340.5.1 Earthing material and installation shall comply with the latest edition of the Indian electricity rules and relevant standards and code of practices of Indian standards.
- C1340.5.2 Earthing strip in the concrete shall be buried at minimum 50mm depth. At the existing location of the site, the bidder shall carry out necessary works to cut the slab and to embed the strip within the slab at specified (50mm) depth.
- C1340.5.3 All the connection between the main earthing strip (buried at 50mm depth) and equipment shall be done through the earthing riser. The riser shall be of same size of the main earth conductor and shall have suitable holes for the connection of the equipment earth strips.
- C1340.5.4 Risers from the earthing grid to the equipment/structure to be earthed shall be terminated to the earthing terminals of the equipment/structure., if the equipment is available at the time of erection of the earthing grid. Otherwise “Earth insert” shall be provided near the equipment foundation/pedestal for future connection to the earthing terminals.
- C1340.5.5 In outdoor areas, risers shall be brought 300mm above the ground level for making connections.
- C1340.5.6 Earthing conductors along their run on cable trench, ladder, columns, beams, walls etc. Shall be supported by suitable welding/cleating at intervals of 750mm.
- C1340.5.7 Cable trays and supports shall be connected to the earth mat at every 30m interval. Whenever it passes through walls, floors etc. sleeves shall be provided for the passage of the conductor. Both end of the sleeve shall be sealed to prevent entrance of water.
- C1340.5.8 Whenever specifically shown in the drawing or not, steel/ RCC columns, metallic stairs etc., shall be connected to the nearby earthing grid conductors by two earthing leads. Electrical continuity shall be ensured by bonding the different sections of hand rails and metallic structures.
- C1340.5.9 All metallic structure, hand rails, fences etc. shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval.
- C1340.5.10 The earth pits shall be suitably labelled and marked for the clear identification. The labelling/markings of the pit shall be done with durable paint.
- C1340.5.11 Separate dedicated clean earth pits shall be provided near the building for communication system, CCTV, LAN, &PA system, etc.
- C1340.5.12 Metallic sheaths and Armour of all multi core power cables shall be earthed at both equipment and switch gear end. Sheath and armour of single core cables shall be earthed at switch gear end only.
- C1340.5.13 Galvanization of GI strip shall conform to class IV of IS: 4736-1986. Hot dipped galvanised strips shall be used for earthing.

- C1340.5.14 The method of earthing for earth mat has to be considered from the viewpoint of step and touch potentials in the area extended at least 10 meter from the HT towers so as to ensure that the area in the vicinity of the site is safe from the viewpoint of touch potential under fault conditions.
- C1340.5.15 The attainable and permissible values of the step and touch potential in the design of the earthing grid in the substation shall be calculated as per IEEE 80, and it shall be ensured that the attainable step and touch potential are less than the permissible step and touch potentials. For step and touch potentials, current distribution factors shall be considered as 1 and duration of rated fault current shall be 1 second.
- C1340.5.16 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of CEA safety guidelines, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.
- C1340.5.17 The Contractor shall design (at design fault level) the earth mat to get the touch potential and step potential within safe limits as per the standards and earth resistance shall be not more than 1 ohm.
- C1340.5.18 In case of non-uniformity of soil resistivity, or to achieve permissible step and touch potentials, it may be necessary, to embed the normal electrodes or deep bore electrodes at the peripheral of the earth mat. In case of hard soil/dry fissured rock/hard rock, treatment with Bentonite clay, may be necessary. The design calculations and drawings are to be got approved from client/consultant before taking up the work for earthing system.
- C1340.6 Chemical Earthing
- C1340.6.1 Providing Earthing system as per IEC 62305 part3, IEC 60364, IEC 62561 part 2, IS 3043, UL 467 & UL 96 standards, IEEE: 80-2000
- C1340.6.2 Maintenance free earthing arrangement to carry fault current with 250 microns molecularly copper bonded solid high carbon steel rod of diameter 20mm and minimum length 4 Meters (1 meters*4) tested for 10/350 micro second wave form, stainless steel connectors and fasteners for connecting electrode with earthing conductor/strip with earth enhancing mineral compound is recommended as per above mentioned standards. The electrode shall be hand driven or hammered in to earth for soft soil and drilling for rocky and hard soil.
- C1340.6.3 Earthing System comprises of molecularly bonded copper of 99.9% purity on low carbon steel of 4m length (1m (219 20 CU) x 4 nos.), having a diameter of 20mm with copper coating thickness of 250 microns with self-coupling bore and peg arrangement (without the need for external coupler) with fault current withstand capability of 25 KA rms value for 3 second. For obtaining desired length, the number of rods shall be increased and is provided with Universal Clamp (2730 20 VA) made of SS 304 for clamping the cable/flat conductor to the rod. Impact point (219 20 IP) on the bottom rod for easy insertion.

- C1340.6.4 Earth enhancing mineral compound (ECS PB 12.5) is used for improving the soil conductivity. Earth enhancing mineral compound shall be so designed and constructed that in normal use their performance is reliable and without danger to persons and the surroundings. The material shall be mineral inert to sub soil and shall not pollute the environment. It shall provide a stable environment in terms of physical and chemical properties and exhibit low resistivity. It shall not be corrosive to the earth electrode itself. The material should have a resistivity less than 50 Ohm meter. It should be free from hazardous substances. The mineral compound is required to have minimum 12.5 Kg of the total composite.
- C1340.6.5 FRP (UFE FRP) Earth electrode inspection chamber with heavy duty cover should be used to cover the Earth Rod. The dimension shall be 250mmx 250mm x 250mm with a weight bearing capacity of 15KN. The earth resistance shall be less than 1 Ohms. Additional earth electrode shall be driven one over the other or using parallel earth electrodes to achieve the specified earth resistance value, if the soil resistivity is found high. For driven rod method the earth enhancing mineral compound has to be filled at a depth of 0.6 meter from surface and excavating a manhole size of 0.275meter length and breadth. For auguring method, the earth enhancing mineral compound has to be mixed with garden soil and filled in the entire length of rod.

C1341 PIPE EARTHING AND PLATE EARTHING

C1341.1 General

C1341.1.1 All cladding or steel work should be bonded to the earthing system, as should all structural steel work. A main earth bar should be provided, so disposed as to allow of the shortest subsidiary connections to all major equipment, such as DG set, Substations and electrical panel boards. When piles are used they should be bonded by welding and connected to earth bonding bars. All earth connections shall be visible for inspection.

C1341.2 Electrode materials and dimensions

- The materials and minimum sizes of earth electrodes shall be as per fault level calculation.
- GI pipe electrodes shall be 100 mm dia. and 13 mm thick
- Pipe electrode shall be buried in the ground vertically with its top not less than 20cm below the ground level. The installation shall be carried out as per IS: 3043 amended up to date and as directed by the Employer.
- Plate electrode shall be buried in ground with its face vertical, and its top not less than 2m below the ground level. The installation shall be carried out as per IS: 3043 amended up to date and as directed by the Employer.
- When more than one electrode is to be installed the distance between the pipe electrodes shall be 5m and that between plates shall be 8m.
- The strip or conductor electrode shall be buried in trench not less than 0.5m deep.

- If the conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point or as directed by the Employer.
- All joints in copper conductor should be tinned properly.

C1341.3 Earthing Conductor

- The earthing conductor (protective conductor from earth electrode up to the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.
- Protective (Earth continuity/Loop earthing) Conductor)
- The material and size of protective conductors shall be as specified in the specification

C1341.4 Location for Earth Electrodes

- Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Employer.

C1341.5 Protective (Loop earthing/earth continuity) Conductor

- Earth terminal of every switchboard in the distribution system shall be bonded to the main earth bus.
- Two protective conductors shall be provided for a switchboard.
- A protective conductor shall securely connect the earth connector in every distribution board (DB) to the earth bus.
- All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor.
- Provision should be given for the testing of earth electrodes by connecting a group of rod driven electrodes to the main earth grid through a bolted link adjacent to the electrodes in a sunken concrete box. Simpler disconnecting arrangements are not acceptable.

C1341.6 Marking

- Earth bars/terminals at all switch boards shall be marked permanently as "E"
- Main earth terminal shall be marked Safety Earth – Do Not Disconnect.

C1341.7 Test of Earthing

- The following earth resistance values shall be measured with an approved and calibrated earth tester and recorded.
- Each earth grid, earth mat, earth pit, piles earth.
- Earth continuity & bonding conductors

- Earthing system as a whole.

C1342 415 V SILENT DIESEL GENERATOR SET

C1342.1 Scope

- The scope includes supply, Installation, Testing & Commissioning of DG Sets enclosed in their acoustic enclosure and skid mounted with all standard accessories like control panels, power outlet panel, radiator, exhaust piping, fuel piping, ventilation system, acoustic enclosure etc. The DG sets will be supplied with separate day Tank.
- It is the responsibility of contractor to get approval from DGMS and other governing agency
- Preparation of related schematic and GA drawings for DG installation, exhaust piping, fuel piping, ventilation system, acoustic enclosure, etc.
- Any related work covering supply of installation materials, consumables, etc. whether specified or not, to render the system fully functional and conforming to the best Engineering standards. This shall include battery charging.
- The bidder shall arrange for all Design and civil construction works for making foundation for DG sets, diesel tank, making trench in panel room. The design of the foundation shall be approved by Employer.

C1342.2 General

C1342.2.1 The output from the unit shall be rated KVA as per the north jetty emergency load, 415 volts, 3 ph., 50 Hz, 0.8 power factor.

C1342.2.2 The estimated capacity of the DG set is 2 x 250KVA. However, the contractor shall do the critical load calculation and accordingly the DG to be sized.

C1342.2.3 Providing underground Diesel storage tank is also in the scope of the contractor. A fuel filling pump to be supplied along with the diesel generator.

C1342.3 Environment Conditions

C1342.3.1 DG set shall be required to operate as standby unit under the following environmental conditions:

Ambient temperature	:	45 deg. C
Relative humidity	:	above 90%
Altitude	:	Sea-level

C1343 DIESEL ENGINE

C1343.1 General

C1343.1.1 The engine shall comply with the requirements of relevant BS 649/BS 5514.

C1343.1.2 Engine shall be designed for maximum reliability ensuring uninterrupted operations.

- C1343.1.3 Engine shall be capable of delivering 10% overload for a period of one hour in any consecutive twelve (12) hour period.
- C1343.1.4 The values of rating, rotational speed and brake mean effective pressure (BMEP) for a specific engine design will not be accepted unless they are published as catalogue data.
- C1343.2 Engine Type
- C1343.2.1 The engine shall be heavy duty, industrial type four stroke delivering matching BHP at 1500 rpm, turbo charged radiator cooled suitable for standby duty.
- C1343.2.2 The engine and auxiliary system shall be designed for safe start, stop and running on high speed diesel (HSD).
- C1343.2.3 The engine performance shall confirm to ISO: 3046/BS: 5574.
- C1343.3 Engine Governor
- C1343.3.1 The engine governor shall be electronic.
- C1343.4 Load Acceptance
- C1343.4.1 The set shall be capable of accepting at least 60% of rated load in a single step from an initial start-up condition.
- C1343.5 Filters
- C1343.5.1 Filters of the replacement element type shall be provided on the engine for fuel oil, lubrication oil and air intake.
- C1343.6 Starting System
- C1343.6.1 Engine starting shall be done through 24 V DC battery system
- C1343.6.2 Sizing of starting system should be in accordance with the engine manufacturer's recommendations, however Battery shall be suitable for six successive starting attempts each of 10 seconds duration with a gap of 5 seconds between successive starts.
- C1343.6.3 Each battery is provided with a charger to charge the batteries when the set is not running. The charger shall get disconnected while the generator set is running.
- C1343.6.4 Batteries shall be maintained in a warm (20°F to 110°F) atmosphere to assist in quick starting.
- C1343.6.5 The battery system shall be of lead acid automotive type.
- C1343.6.6 The battery shall be supplied complete with electrolyte and accessories. The accessories shall include battery stand, battery leads with terminal ends acrylic top cover and inter battery connectors.
- C1343.7 Flywheel Guards
- C1343.7.1 Flywheel guards should be provided as required.
- C1343.8 Engine Control Unit
- C1343.8.1 An engine control unit free from vibrations comprising of the following devices with sensors (mounted at engine) shall be provided as minimum:

- Water temperature gauges for jacket water temperature
- Water pressure gauge
- Tachometer for engine speed
- Lubricating oil, pressure and temperature gauges
- Automatic shutdown and indication for low lubricating oil pressure, over crank, low coolant level, high cooling water temperature and engine over speed.

C1344 ENGINE AUXILIARIES

C1344.1 Cooling System

C1344.1.1 Cooling system shall be radiator type.

C1344.1.2 Anti-freeze liquids and corrosion inhibitor as recommended by engine manufacturer shall be used to obviate the danger of damage occurring from the use of incompatible or improper liquids or inhibitors.

C1344.2 Intake and Exhaust System

C1344.2.1 A residential type exhaust silencer of suitable size for exhaust run shall be provided complete with all support frames etc. to reduce engine exhaust noise. It should be kept as straight as possible.

C1344.2.2 Dry type air-inlet filter, exhaust manifold, mufflers shall be used. Type of filter selected shall be to fit the environmental conditions at the site.

C1344.2.3 Combustion air shall be taken directly from outside.

C1344.2.4 The air-intake and exhaust shall be so located as to preclude the contamination of fresh air with exhaust gases.

C1344.2.5 To dispose of the radiant heat given off by the exhaust pipe, sheet metal ductwork shall be supplied with 50 mm of space between the ductwork and the exhaust pipe

C1344.3 Exhaust stack height

C1344.3.1 In order to dispose exhaust above building height, minimum exhaust stack height should be as follows. However, it has to meet the CPCB requirements.

C1344.4 For DG set up to 1000KVA:-

$$H = h + 0.2 \times \text{Sq.rt of (KVA)}$$

Where

H = height of exhaust stack

h = height of building

C1344.5 For DG set above 1000KVA:-

C1344.5.1 30m High or 3m above the building height (whichever is higher)

C1344.5.2 Insulation of the exhaust pipe shall be carried out as follows

- C1344.5.3 Surface shall be thoroughly cleaned with wire brush and rendered free from all foreign matter and grease.
- (i) 75 mm thick insulation (glass wool) fixed tightly to the surfaces butting all joints and tightened with lacing wire. (Type of insulation to be got approved by the Employer).
 - (ii) Insulation to be wrapped with aluminium sheet 26 gauge and joints overlapped and sealed with adhesive tape and in addition fixed with cadmium coated steel screws.
- C1344.6 Fuel Oil System
- C1344.6.1 The fuel-injection system shall be complete with PT fuel pump, injectors, fuel filters and self-contained piping.
- C1344.6.2 The system shall generally comprise of
- Day tanks capacity shall be for 8 hour running at 75% load.
 - Pumps required for conveying fuel from day tank to engine. Critical pumps should be provided in sets (1 working + 1 standby)
 - The day tank shall also act as a relief and by-pass tank for fuel oil that is circulated to the injectors whereupon any excess fuel is by-passed back to the day tank.
- C1344.7 Fuel Filtering System
- (a) The primary filtering system shall be located at day tank inlet.
 - (b) In addition, the engine shall have secondary filtering system.
- C1344.7.1 Both filters shall be capable of absorbing water.
- C1344.8 Lubricating Oil System
- C1344.8.1 The pressure lubrication system shall be used. The filter shall be of simplex type with paper element. The full flow lubricating oil filter can be mounted on the lubricating pump or remote mounted with flexible lines.
- C1344.9 Piping and other Associated Connections
- C1344.9.1 All piping, flexible connections, flange valves, seals, fittings etc. shall be supplied by the Contractor for all the associated auxiliaries of equipment.
- C1345 ALTERNATOR**
- C1345.1 General Requirements
- C1345.2 Type
- C1345.2.1 The Generator shall be air cooled, brushless, 3 phase, fan ventilated, synchronous type fitted with heavy duty, long life ball or roller bearing with forced lubrication or lubricant packed for approximately 4000 hours of running without attention. The alternator shall be manufactured in accordance with BS 2613 IEEE-341 or as per relevant BIS, ISO, DIN, NEMA standard. The unit shall be horizontally mounted.

C1345.3 Protection

C1345.3.1 Enclosure shall possess minimum IP23 degree of protection.

C1345.4 Insulation

C1345.4.1 Insulation throughout shall be class H, temperature rise by resistance. All windings shall be impregnated to allow operation in climatic conditions specified in this volume.

C1345.4.2 The Alternator shall be provided with following minimum accessories:

- Resistance temperature detectors
- Bearing temperature detectors
- Space heaters.

C1345.5 Basic Ratings

The basic ratings of the Alternator shall be as follows:

Rated voltage	: 415 Volts
Speed	: 1500 rpm
Rated power output	: 2 x 250KVA (Continuous rating)
Frequency	: 50 Hz
Number of phases	: Three
Power Factor	: 0.8
Type	: Brushless, synchronous, self-excited self-regulated
Neutral Earthing	: Solid grounding
Voltage regulation	: +1% of rated voltage from no load to full load at any power factor between 0.8 lagging and unity
Type of cooling	: Self-cooled fan ventilated ventilation

C1345.6 Metering and AMF Control Panel

C1345.6.1 This is intended for operation of DG set in auto mode. The panel shall be sheet steel construction and arranged for free standing, floor mounting, and bottom entry with front and rear access. The interior wiring of the cubicle shall be looped and clipped and all wire ends are to be clearly identified. Any printed circuit boards shall be tropicalized.

C1345.6.2 Following metering and protection devices as a minimum requirement shall be included in each panel:

C1345.7 Metering Instruments

- Voltmeter with selector switch
- Ammeter with selector switch
- Frequency meter

- KW meter
- Battery voltmeter
- Power factor meter
- Hours run indicator
- KWH meter
- KVAR meter
- Excitation current ammeter
- Excitation voltmeter
- Engine Speed Indicator

C1345.8 Push Buttons

- Engine starts PB.
- Engine Stop PB.
- Lamp Test PB.
- Reset PB.
- Emergency Trip PB.

C1345.9 Indication Lamps

- DG set on
- Load on DG set
- Set running
- Mains available
- Mains failure
- Start failure
- Generator over current
- Generator high voltage
- Generator low voltage
- Earth fault
- High engine speed
- Low engine speed
- Low fuel level
- High fuel level
- Charge failure
- Generator winding temperature high
- High bearing temp.

- Low lubricating oil pressure
- High lubricating oil temp.
- Engine jacket water temperature high
- Engine jacket water pressure low
- Reverse power
- Low fuel oil pressure
- Rotor diode failure

C1345.10 Protective Relays

- IDMT relay (Over current and earth fault)
- Over voltage relay
- Under voltage relay
- Reverse power relay
- Field failure relay
- Differential relay
- Phase failure relay

C1345.11 MFT

- Voltage – Phase-to-Phase & Phase-to-Neutral
- Current – line to neutral
- Power – kW, kVAH, kVAR (Avg. & Ph. wise)
- Energy – kWh, kVAH, kVARH
- Power Factor – Average & Ph. wise.
- System frequency
- Import & export kWh & kVARH.
- RS 485 MOD BUS

C1345.12 Accessories

- The following accessories shall be supplied with the DG set:
- Common base frame for the engine and alternator.
- Anti-vibration mounts of requisite capacity (Dunlop series S make).
- Protective guards for all rotating parts.
- Electric driven lube oil priming pump complete with hosepipes and couplers.
- 18 SWG galvanised sheet steel trays beneath the engine and fuel tank to collect the leakage oil.

C1345.13 Acoustic Enclosure

C1345.13.1 The acoustic enclosure shall be of free standing, floor mounting type integral with the DG set. The enclosure shall be provided with rugged heavy-duty structural steel base frame with chequered plate flooring on which the DG set is to be mounted. The enclosure shall be prefabricated factory-built and modular in construction. The enclosure shall consist of acoustically treated panels housed in rugged steel frames, which shall be bolted together to form the body of the enclosure. Hinged doors shall be provided, on either side, which shall also be acoustically treated, thereby providing easy access to the DG set. The construction of the acoustic enclosure shall be such that with both the acoustic doors open on the either side, full access is available to the engine and alternator. The enclosure shall have suitable openings in the roof module for exhaust piping. Proper illumination shall be provided inside the DG set enclosure.

C1345.13.2 With the above Enclosure, the sound pressure levels when measured at a distance of 1 meter outside the Acoustic Enclosure shall be around 70 dB (A) under free field conditions.

C1345.14 Painting

C1345.14.1 The outside enclosure shall have a factory applied weather proof powder coated finish while all other structure shall have appropriate corrosion proof coating suitable for a coastal climate. Steel structures shall have a coat of Zinc chromate primer and a coat of synthetic enamel paint of approved shade. The exhaust pipe/duct and stack shall have appropriate high temperature resistant paint. Any paint or coating damaged during transportation and erection shall be rectified at site to the satisfaction of the Employer.

C1345.15 Installation

C1345.15.1 The foundation drawing of the D.G. Set shall be provided by the Contractor, and it is the responsibility of the contractor to provide the statutory authority with all drawings, design calculations, etc. well in advance as per the manufacturer's specifications and meeting statutory standards and requirements. Contractor shall provide skid mounting with common base plate and all mounting structure, shims, etc., for the diesel alternator set. Contractor has to mount the engine with alternator on the base plate and align and assemble the set. Suitable anti-vibration mountings as approved for the complete set shall be provided. Coupling (both halves) with guards shall be provided. Contractor shall provide insulated exhaust piping with Aluminium cladding for each set and there should be hood on top of the exhaust pipe and the work should be as per electrical inspectorate rules and pollution Control specification. The stack and stack foundation shall be provided as pollution Control specification. The Structural Support for the DG exhaust shall be similar to the existing DG exhaust support at site.

C1345.16 Test at Manufacturer Works

C1345.16.1 The routine tests and full load test on Engine, Alternator shall be carried out at manufacturer's work in accordance with applicable Indian standards in the presence of Client representative.

Noise, Vibration, pollution measuring instruments to be calibrated properly and certificates to be produced while conducting test.

C1345.17 Test at Site

C1345.17.1 Following tests shall be conducted at site in the presence of the client's representative. The contractor shall provide all testing equipment, labour, fuels and consumables required for the testing.

C1345.17.2 Insulation resistance test on alternator, control panel

- Checking the AMF operation both on auto and manual mode.
- Checking of AVR operation.
- Checking vibration levels.
- Full load running for 8 hours continuously. All the readings shall be logged to evaluate the fuel consumption, lube oil pressure, water & oil temperature vis-à-vis the electrical load.

C1345.18 Spares

C1345.18.1 DG set shall be supplied with following spares which shall be handed over at the time of commissioning.

- 2 sets of renewable parts of Oil, Fuel and Air filter
- 2 numbers of Fan belts
- 5 numbers of spare fuses of each type used
- 2 spare relays of each type, sets of fuel injector
- 1 number manual gear pump

C1345.19 Taking Over

C1345.19.1 The Client shall take over the DG set for operation on completion of following.

1. DG set are installed, tested and commissioned as per specification
2. Original test certificates are furnished for Engine, Alternator, Acoustic enclosure and other bought out items.
3. Load trails are successfully carried out
4. The set shall be handed over with First fill of Lube oil, Diesel and along with spare mentioned.
5. Training to at least one Employer and Two technicians shall be provided for operation & maintenance of DG set at Factory.

C1346 UNINTERRUPTED POWER SUPPLY (UPS) SYSTEM

C1346.1 Scope

C1346.1.1 This specification covers the requirements of 100% redundant UPS System for North Jetty substation.

C1346.2 Codes and Standards

C1346.2.1 The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, except where modified and /or supplemented by this specification.

IEC: 62040	:	Uninterruptible Power Systems (UPS)
IS: 3895	:	Mono crystalline semiconductor rectifier cells and stacks.
IS: 4540	:	Mono crystalline semiconductor rectifier assemblies and equipment
IS: 6619	:	Safety code for semiconductor rectifier equipment.
IS: 6297	:	Transformer and inductors for electronic equipment
IS 13947	:	LV switchgear and control gear
IS 6553	:	Environmental requirements for semi-conductor devices and integrated circuits
IS 9000	:	Basic Environmental Testing Procedures for Electronic and Electrical Items

C1346.3 Design Requirements

C1346.3.1 UPS system shall be true on line double conversion, digital type. It shall provide uninterrupted power supply to critical AC loads such as CCTV System, Emergency lights, PA system, EPABX system, Computers etc. UPS shall be located in non-air conditioned room and its equipment shall be designed for design ambient of 45°C.

C1346.3.2 UPS shall be parallel redundant consisting of Chargers, Inverters, Battery, SMPS based static voltage stabiliser, Static bypass and Maintenance bypass, UPS DB, MCCB box for battery, etc. UPS shall have RS 232 /RS 485 Interface complete with Communication software

C1346.3.3 Lead Acid maintenance free storage battery units of capacity to meet 1 Hour UPS backup requirements shall be complete with all accessories. While sizing each battery the following factors shall be taken into consideration:

- Aging factor as 0.8
- Temperature correction factor
- Backup period - Minimum 1 Hour
- Power Factor - Unity

C1346.3.4 The UPS shall have an over load capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 sec. The inverter shall have sufficient I2t capability to clear fault in the maximum rated branch circuit.

C1346.3.5 The changeover from inverter to by-pass transformer shall not be more than 5 milli-seconds.

C1346.3.6 On failure of one UPS, the other UPS will take over the 100% load automatically without any interruption and on failure of both UPS; STATIC VOLTAGE STABILISER will take over the power supply distribution and will supply the power without any interruption.

C1346.4 Technical Requirements

C1346.4.1 UPS shall be provided with rated output powers to suit the load in each case. The rating of UPS shall be based on the total load calculation. Lead Acid maintenance free storage battery units with closed top cells of capacity to meet the 1 hour UPS backup requirements shall be complete with all accessories and devices. The UPS shall be double line online conversion type.

Rated output power	To serve the loads for minimum 30 minutes.
Input	415 Volts, AC + 10% at 50 Hz + 5%
Output	240/110 Volts, AC, 50 Hz/415 Volts, AC, 50Hz
Static Output Tolerance	+ 1 %
Dynamic Output Tolerance	+ 5 % (without Battery)
Switch over Time	Less than 10 milliseconds
Design Reference Ambient Temperature	45 °C

- C1346.4.2 The rectifiers shall operate according to the constant voltage current limiting principle and shall incorporate a “Soft Start” feature to gradually accept load on initial energizing.
- C1346.4.3 Suitable protection shall be provided in the control circuits to guard against instability of rectifiers due to electrical oscillations, which may be present in the input supply as caused by emergency DG set.
- C1346.4.4 The UPS system including the stabilized bypass shall be galvanically isolated from input power supply system by providing double wound Isolation transformers. A rectifier shall have a double wound transformer at its input.
- C1346.4.5 Transient / surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surge & voltage spikes. The UPS shall be provided with automatic sequence and power walk in circuits with adjustable time delay such that the rectifiers and inverters can start operating automatically when incoming AC power is restored allowing the UPS to be loaded automatically.
- C1346.4.6 The inverters shall operate satisfactorily for variation of DC bus voltage from fully discharged condition of the battery to rapid charge voltage of the battery and inverter output load current waveform having a relative harmonic.
- C1346.4.7 It shall be possible to vary the inverter output voltage steplessly within +/- 5% of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation.
- C1346.4.8 The stabilized bypass supply shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current ten times the rated output for the duration more than the fault clearing time of the type of fuse provided.

- C1346.4.9 The load transfer devices shall comprise of continuous rated static elements in both inverter and stabilized bypass supply. The inverters shall be phase locked to the stabilized bypass power supply as long as stabilized bypass supply frequency remain within + 3 % to – 5% of nominal. When bypass supply frequency variation exceeds the above limits, the inverters shall be delinked from mains. Free running frequency tolerance limit shall not exceed +/- 1%. Facility shall also be provided for adjustment of synchronizing frequency from 1% to 5% in the steps of 0.5%.
- C1346.4.10 Facility shall be provided to manually and automatically initiate transfer of the load from inverters to the stabilized bypass supply and manually from stabilized bypass supply to the inverters. Under voltage and over voltage sensing levels to initiate transfer shall be adjustable. The maximum transfer time between inverters and bypass supply shall not exceed 5m.sec and 20 m. second in synchronous and asynchronous mode respectively.
- C1346.4.11 All breakers shall be adequately rated for continuous rating as well as breaking capacity as applicable. Paralleling of breaker / switch / contactor poles to achieve the required current rating is not acceptable. All output isolating device shall be double pole type.
- C1346.4.12 All the thyristor, diodes and other electronic devices of UPS shall be protected with high speed semiconductor fuses. I² / t co-ordination characteristics between fuse and semi-conducting power devices shall be furnished.
- C1346.4.13 Radio Frequency Filters shall be provided at the input and output of UPS to reduce radio frequency interference.
- C1346.4.14 Maximum noise level from UPS system at 1 metre distance, under rated load with all normal cooling fans shall not exceed 65dBA.
- C1346.4.15 MCCB shall be TPN type for incoming supply to Rectifier circuit & Standby source, DP type for battery & ACDB incomer/outgoing. It shall be quick make, quick break, and independent manual type with trip free feature. All MCCB shall have the following:
- Short circuit release
 - ON/OFF Trip position indicators
 - Test trip push button
- C1346.4.16 Copper cable shall be used for interconnection among UPS & STATIC VOLTAGE STABILISER etc.

C1347 OPERATIONAL REQUIREMENT

C1347.1 Normal Mode Operation

- C1347.1.1 During the normal operation the UPS shall be used to provide power to the critical loads. Under normal conditions, the loads shall be supplied by the inverters. The Rectifier shall derive power from normal/primary AC source and supply DC Power to the inverters. Chargers shall feed regulated DC power to their individual inverter banks and simultaneously float charge the backup batteries.

- C1347.1.2 The individual inverters shall operate in parallel and shall share the load equally. The inverters shall be connected to load side through static switches. Outputs of the inverters are paralleled after the static switches and connected to load bus.
- C1347.2 Emergency Mode Operation
- C1347.2.1 Upon failure of the normal AC source, the loads shall continue to be supplied by inverters which, without any switching shall obtain their power from storage battery. In case of failure of the main supply, battery shall supply back up DC power to UPS system for duration of sixty (60) minutes.
- C1347.2.2 Upon restoration of the normal AC source, the rectifier/battery chargers shall power the inverters and simultaneously recharge the battery. This shall be automatic causing no interruption to critical loads.
- C1347.2.3 On failure of an inverter due to any one of the following faults the entire load shall be automatically transferred to the other inverter.
- Excess inverter output voltage
 - Very low inverter output voltage
- C1347.3 Failure of inverter
- On failure of one inverter, the faulty one shall be isolated from load instantaneously and the other inverter shall continue to feed the load. In case, the other inverter also fails, automatic change over to standby transformer shall be effected through static switches.
 - Parallel operation (load sharing) shall start automatically when the fault condition clears. If the transfer was due to the inverter failure the retransfer (parallel operation) shall be manually initiated.
 - The entire load shall be automatically transferred to the alternate AC source through static switch within a maximum of four(4) milliseconds under the following conditions:
 - ✓ Battery discharged completely
 - ✓ Initiation of manual control switch.
 - ✓ Failures of both the inverters
 - ✓ Inverter output voltage is more than +/- 5 % of the rated value
 - ✓ The load current exceeds specified over load rating and time.
 - In case of failure of both inverters, static transfer switch shall changeover within five (5) milliseconds to connect the alternate AC source to the load. On restoration, the retransfer shall be manually initiated.
 - Retransfer of load shall be accomplished automatically by synchronizing the inverter to the alternate source and allowing the inverter to ramp into the load and then disconnecting the alternate source.
 - Manual transfer facility through static transfer switches shall be provided in either direction.

- In case of maintenance requirement, it shall be possible to isolate inverters and static bypass switches from load and connect alternate AC source to the load through manually operated, make before break manual transfer switch.
- Bypass switches shall be so interlocked that there is
- No interruption in output to load
- No paralleling of raw supply and inverter output.

C1347.4 UPS Enclosure & Accessories

- C1347.4.1 UPS shall be metal enclosed, fixed type, suitable for indoor mounting on floor. Panel shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm for load bearing members and 1.6 mm for non-load bearing members. Suitable synthetic rubber gaskets shall be provided to achieve a degree of protection of IP-31. At bottom removable gland plates of at least 3 mm thick shall be provided. All incoming and outgoing cables shall be terminated on suitable terminal blocks.
- C1347.4.2 Control and selector switches shall be of rotary stay put type with escutcheon plates showing the functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.
- C1347.4.3 Electronic equipment's shall be of modular design consisting of plug in modules in standard 19 inches metallic racks with metallic card guides. Card to card wiring shall be preferably through a motherboard. Unplanned jumpering and track modifications are not permitted. Mechanical interlocks to prevent wrong insertion of cards should be provided. Each card shall have its junction and test points identified. UPS panel shall be provided with an illuminating lamp, space heater with thermostat and one 5 A socket. MCB shall be provided separately for each of the above. Microprocessor based Window annunciator shall be provided for alarm annunciation with acknowledge, test and reset push buttons and a buzzer.
- C1347.4.4 UPS shall be furnished completely wired up to power cable lugs and terminals blocks ready for external connection. The control wiring shall be 1.1 kV grade PVC insulated stranded copper conductors of 1.5sq.mm. Control wiring / termination at electronic cards shall not be less than 0.5sq.mm. Control terminal shall be suitable for connecting two wires with 2.5sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification at least 20 % spare terminals shall be provided for circuits.
- C1347.4.5 Power and control wiring within panels shall be kept separate. Any terminals or metal work which remains alive at greater than 115 V when panel door is opened shall be fully protected by shrouding. An air clearance of at least ten (10) mm shall be maintained throughout all circuits, except low voltage electronic circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

- C1347.5 Construction of Battery
- C1347.5.1 Lead Acid (Valve regulated) sealed maintenance free Plate type batteries shall be float charged at 2.15 to 2.20 Volts per cell and chargers shall also be capable of boost charging the associated DC battery up to 2.7 Volts per cell at the desired rate. Batteries shall be rated for 10 hour discharge rate (C10) as per manufacturer data.
- C1347.5.2 Containers shall be made of suitable glass fibre reinforced plastics or Polypropylene. Containers shall be robust, heat resistance, leak proof, non-absorbent, acid/alkaline resistant, non-bulging type and free from flaws such as wrinkles, cracks, blisters, pin holes etc.
- C1347.5.3 Batteries shall have thick plates designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion. The positive and negative terminals shall be clearly marked.
- C1347.5.4 Each cell shall be separately supported on porcelain insulators fixed on to the racks with adequate clearance between adjacent cells. Breathers/Vent plugs etc. shall be provided for each cell. It shall be anti-splash type and having more than one exit hole to allow the gases to escape freely but prevent the acid spray from the battery.
- C1347.5.5 Lead coated copper inter-cell connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively lead coated to prevent corrosion. All the terminals and cells, interconnections shall be fully insulated or have insulation shrouds/covers.
- C1347.5.6 End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded copper conductors and PVC/XLPE insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied. All connectors and lugs shall be capable of continuously carrying the 60 minute discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared. Anti-corrosive gel shall be applied at the Battery terminals.
- C1347.5.7 Wooden racks shall be provided for batteries for multi-tier installation. These racks shall be made of good quality first class seasoned teak wood. They shall be free standing type mounted on porcelain insulators. Numbering tags, resistant to acid for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor.
- C1347.6 Spares & Tools:
- The following accessories shall be provided with batteries.
- | | |
|------------------------------------|----------------------|
| Cell testing voltmeter 3-0-3 volts | : 2 Nos per Battery |
| Spanners | : 2 sets per Battery |
- The following maintenance spares shall be provided as a minimum along with UPS

Inter cell connectors	: 10 Nos.
Inter row connectors	: 2 Nos.
Battery stand insulators	: 2 Nos
Cell insulators	: 2 Nos
Nuts, bolts & washers	: 10 pieces each
Vent plugs	: 10 Nos.
Spare dry cell	: 4 Nos.

C1347.7 Metering & Protection

C1347.7.1 The following parameters shall be measured either through LCD display or separate meters in UPS panel front.

- Input voltage
- input current
- Charger Voltage
- Charger current
- Inverter output voltage
- Inverter output Current
- Inverter output frequency
- stabiliser Voltage
- stabiliser current
- Battery voltage
- battery current

C1347.7.2 For remote metering of the following parameters, 4-20 mA transducer outputs shall be provided.

- Inverter output voltage
- Inverter output Current
- Inverter output frequency

C1347.7.3 For remote indication/ annunciation, potential free contact shall be provided for the following. RS485 port shall also be provided.

- Mains voltage fail
- Rectifier fail
- Battery breaker off
- Inverter fail
- Load on bypass
- Overload
- Over temperature

- Manual bypass ON
- Static bypass switch off
- Output switch open
- Inverter ON/OFF
- Asynchronous condition
- DC ground fault
- Synchro inhibited

C1347.7.4 The following LED alarm indications shall be provided on the mimic on the panel.

- System fault
- Rectifier charger failure
- Inverter failure
- Battery under voltage
- Thyristor over temperature
- Fuse failure
- Overload
- Static transfer to standby
- Transfer inhibited
- Overload shutdown
- Emergency shutdown
- Battery circuit open
- AC mains failure
- AC standby source mains failure
- Manual bypass ON
- Fan failure
- Asynchronous condition
- DC ground fault
- Low DC

C1347.7.5 The following LED status indications shall be provided on the panel.

- Mains ON
- Charger ON
- Battery on load
- Inverter ON
- AC standby source ON

- Inverter on load
- Manual bypass ON
- Load on static bypass

C1347.7.6 The following protections shall be provided as a minimum.

- MCCB at each input supply
- DC MCCB at Battery supply
- Filter at input
- Surge suppressor across transformer secondary
- Semiconductor fuses for SCR bridges
- HRC fuses for filter capacitors
- DC over voltage protection
- Charger input current limit
- Battery current limit
- Under voltage on input side
- Negative sequence current protection on input side
- Overload on inverter
- DC ground fault protection
- HRC fuses in control circuit
- Under voltage / Over voltage protection
- Any other protection required for safe operation of the UPS.

C1347.8 Painting

C1347.8.1 The fabricated parts shall undergo a treatment of degreasing, pickling and two coats of primer before being given the epoxy finish two coats of final paint shall be applied. The external and internal surface of the board shall be powder coated epoxy finish of grey shade RAL 7032. The final thickness of paint film on steel shall not be less than 150 microns. All bezels, handles, screws, bolts, washers, hinges, etc. shall be of the best quality electro galvanized or passivated to with stand attack from corrosive atmosphere.

C1347.9 Testing and Inspection

C1347.9.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, tested and commissioned at all the stages, as per approved Quality Plan.

C1347.9.2 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. The Purchaser shall review the type tests certificates furnished by the Contractor at contract stage.

- C1347.9.3 For the various bought out item test certificates from equipment manufacturer shall be furnished.
- C1347.9.4 All tests shall be conducted as per relevant IS/IEC standards and shall be performed in the presence of Employer's representative, if so desired by the Employer. The Contractor shall give at least 15 days advance notice of the date when the tests are to be carried out.
- C1347.9.5 Copies of certified reports of all type tests carried out on similar type and rating shall be furnished. In absence of such type tests certificates or in case such certificates are not found to be meeting the relevant standard requirements, vendor shall conduct all such tests according to relevant standards free of cost to Employer and reports shall be submitted to Employer for approval.
- C1347.9.6 Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Employer / Employer's written approval of the test reports.
- C1347.9.7 Following tests shall constitute functional tests for the panel as per IS: 4540 & IS: 9000
- Voltage regulation
 - Ripple content at different loads and noise measurement
 - Insulation resistance test
 - General operation
 - Voltage/current stability test
 - High voltage test
 - Measurement of surface temp. of charger panel
 - Current limiting features.
 - Efficiency & PF measurement
 - Temp. Rise test
 - Short circuit at full load
 - Short circuit at No load
 - Connection checking of Rectifier assembly.
- C1347.10 Following tests shall constitute type tests on the panel.
- Degree of protection Test for Panel
 - Vibration Test of the Electronic Card Rack/Panel
 - Environmental Tests on the Electronic Cards
 - RFI Test
 - Surge withstand capability Test
- C1347.11 Following tests shall constitute type tests for transformers
- Short circuit test

- Temp. rise test
- Insulation test
- High voltage test (power frequency)
- Inductive DC voltage drop test

C1347.12 Following tests are to be performed on different electronic controller cards like power supply, firing etc.

- Burn in test for all printed circuit Boards (Routine test)
- Climatic and durability test (vibration, dry test, damp heat cycle low temperature and transportation) in line with IS.

C1347.13 System tests shall be performed on the completely assembled UPS system at Manufacturer's works. System tests shall include the following:

- Frequency regulation
- Voltage regulation
- Current limiting feature
- Voltage & frequency control of inverters for synchronisation
- Harmonic content tests
- Transfer of load through static switch due to inverter failure
- Loss on inverter output
- Under voltage
- Load overcurrent
- Manual transfer/Retransfer
- Mains failure/restoration
- Tests on alarms/indications
- Availability test

C1347.13.1 Tests on the AC Distribution board shall be as per the relevant standards.

C1347.13.2 All routine tests covered under IEC-62040-3 shall be conducted on the UPS system in addition to the system tests in presence of Employer or his representative.

C1347.13.3 Endurance test on static switches shall be performed for not less than 10 transfer / retransfer cycles at full load.

C1347.13.4 Surge withstand capability test as per ANSI-C-37-90A/IEEE-47 shall be performed.

C1347.13.5 The complete assembled UPS system shall be operated at rated load under relevant ambient conditions for not less than 96 hours continuously prior to release for shipment.

C1347.14 Taking Over

C1347.14.1 The Client shall take over the UPS for operation on completion of following.

1. UPS IS installed, tested and commissioned as per specification
2. Load trails are successfully carried out
3. Training to at least one Employer and Two technicians shall be provided for operation & maintenance of UPS at Factory or Site.

C1347.15 Rectifier Transformer & Rectifier (415V/220V 500KVA)

C1347.15.1 The contractor shall design, manufacture, supply, install, test and commission the 500KVA, 220V DC Transformer rectifier system to feed DC power supply to the Vessel.

C1347.15.2 The construction of the transformer rectifier system shall meet all the Indian and International standards. It will be outdoor type suitable for marine environment.

SS Type enclosure to be provided.

Commissioning spares shall be supplied with the Rectifier unit.

C1348 BATTERY & CHARGER SYSTEM

C1348.1 DC Control Power Supply

C1348.1.1 The battery charger float cum boost charger with common battery bank and associated DC distribution board shall be used to provide control supply for the switchgear installed for power distribution system. DC Voltage shall be 110DC. Battery chargers shall be provided at both MES substation and North jetty substation.

C1348.1.2 Battery: The tentative batteries shall be 240Ah VRLA, rated for 110 V DC with 1 hours back up at rated load. However, the same to be verified as per load requirement.

C1348.1.3 Mode of Operation: - The battery charger shall be designed with a switch, which gives a choice of three operating modes: a) Automatic mode b) Float mode c) Charge mode

C1348.1.4 The charger shall be regulated to a constant voltage on either of 2 settings, floating & charging, with limited current.

C1348.1.5 General: In this project all the DC loads shall be fed from 110V battery. The calculation for sizing of the battery and its charger are shown below. The battery is to supply the DC power requirements during the following conditions: a) Load on dc system exceeds the maximum output of the battery charger. b) Output of the battery charger is interrupted. c) AC power is lost.

C1348.1.6 The following factors will be considered while designing the battery system:

C1348.1.7 Temperature de-rating factor: The operating temperature affects the available capacity of a cell. The standard temperature for stating cell capacity is 20°C. If the lowest expected electrolyte temperature is below standard a cell large enough to have the required capacity is selected. The capacity deration factor for the same is known as temperature factor. Temperature correction factor shall be 1.14

C1348.2 Design Margin

C1348.2.1 As a prudent design we are to provide a capacity margin to allow for unforeseen addition to the DC system. The performance of a lead acid battery is relatively stable throughout most of its life, but begins to decline at the later stage of its life.

C1348.3 Design Considerations

C1348.3.1 The battery sizing is done for a duty cycle of 60 minutes. The calculated battery size is to be corrected for design margin, aging compensation, and minimum temperature. The batteries considered are sealed, maintenance free lead acid type with a 10 hour discharge rate i.e. C10 batteries. 2 volts batteries with end cell voltage of 1.75V to be considered

C1348.3.2 K factors corresponding to 1.75 end cell voltage and temperature correction factor for the lowest ambient temperature are taken from Exide batteries ltd

C1348.3.3 This calculation is done for battery nominal voltage of 110V DC which is the control supply voltage

C1348.4 Design Basis

C1348.4.1 The loads on the battery are mainly pertaining to HT switchboard control supply only.

C1348.4.2 It is required to be identified which all loads are instantaneous and which all loads are continuous. For example, an 'on' lamp in a breaker feeder is a continuous load, while a tripping relay is an instantaneous load coming in at the time of a trip.

C1348.4.3 A design margin of 5% may be allowed for unforeseen additions or future expansion as well as for below optimum operating conditions.

C1348.4.4 Battery capacity is referred to at a nominal temperature of 20 deg. Celsius. (The factors given by Exide are at 20deg C). A temperature correction factor for the lowest temperature (1-Deg C) is considered while determining the AH capacity of the battery.

C1348.4.5 The voltage at the load terminals shall never be outside +10% and -10% of the nominal voltage.

C1348.4.6 Load Details: The individual loads supplied by battery during the duty cycle maybe classified as continuous or non-continuous. Non-continuous loads lasting for 1 minute or less are designated as momentary loads.

C1348.4.7 The loads, which are energized throughout the duty cycle, are known as continuous loads. These loads are normally carried by the battery charger and are initiated at the inception of the duty cycle.

C1348.4.8 Some of the continuous loads are: Indication lamps, (ON, TCH etc.), continuously energized coils, annunciator loads etc.

C1348.4.9 Momentary loads are non-continuous loads which can occur one or more times during the duty cycle but are of short duration i.e. less than 1 minute. Although the momentary loads may exist for only a fraction of second, it is common practice to consider that each load will last for one full minute because the battery voltage drop after several seconds.

C1348.4.10 Some of the typical momentary loads are: switchgear coil operations (trip and close), etc.

C1348.4.11 The AH capacity of the battery is calculated as:

$$AH = AH1 * K1 * K2 * K3$$

Where K1 = Ageing Factor

K2 = Design Margin

K3 = Temperature correction factor (For the lowest temperature of 10°C)

C1348.5 Float Charger Capacity

ICC = Continuous DC load current which is the total continuous current requirement calculated for the loads

A design margin of 5 % is considered for unforeseen continues loads.

A trickle charging current ITC is as recommended by the manufacturer. (Usually 2%)

$$ITC = ICC * 0.02$$

The total required capacity of the float charger shall be = $ICC * 1.05 + ITC$

Based on the above calculation float charger capacity will be selected.

C1348.6 Boost Charge capacity

C1348.6.1 The boost charger shall be equal to maximum allowable battery charging current (generally 14% of the battery amperage or the float charger capacity, whichever is higher.

C1349 SAFETY EQUIPMENTS

C1349.1 11 KV Grade Rubber Mat

C1349.1.1 HT grade high quality Rubber mat of width 1m shall be provided in front of HT/MV panels. The applicable standard is IS - 15652. It shall be laid throughout the length of the panels and properly pasted to the floor.

C1349.2 Fire Buckets

C1349.2.1 Bottom rounded Fire buckets (Min 3 nos) filled with clean dry sand along with stand shall be provided in convenient and accessible locations . They shall be neatly painted and conspicuously marked. sloping canopy shall also be provided over the fire buckets.

C1349.3 First Aid Boxes and chart

C1349.3.1 2 nos of fully equipped and conspicuously marked Fist Aid Boxes shall be provided at convenient locations. First Aid Charts having first aid instructions printed in English and local language shall be affixed in noticeable places.

- C1349.4 Fire Extinguishers
- C1349.4.1 1 numbers of portable fire extinguishers of DCP/CO2 type of 5kg shall be provided at suitable locations. All the extinguishers shall be of reputed make and should have been approved by Tariff Advisory Committee of India or any other international authorities like FOC - London/NFPA-USA.
- C1349.4.2 All extinguishers shall be ISI marked. All the portable extinguishers shall be of free standing type and shall be capable of discharging freely and completely in upright position. Each extinguisher shall have the instructions for operating the extinguishers on its body itself. All extinguishers shall be supplied with initial charge and accessories as required.
- C1349.4.3 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns. All extinguishers shall be painted with durable enamel paint of fire red colour, conforming to relevant Indian Standards. Dry chemical powder type extinguisher shall conform to IS : 2171. Carbon Dioxide type extinguisher shall conform to IS:2878.
- C1349.5 HT grade Rubber gloves
- C1349.5.1 One set of high quality rubber gloves of HT grade conforming to relevant Indian Standards shall be provided at noticeable locations.
- C1349.6 Other safety equipment
- C1349.6.1 A standard danger board notice in English, Hindi and local language with sign of skull & bones shall be affixed permanently at noticeable places. Warning strips —ISOLATE POWER SUPPLY BEFORE OPENING THE PANEL COVER shall be affixed at the rear side of each panel. Earthing rods shall be provided.

C1350 ROOF TOP SOLAR PV SYSTEM

- C1350.1 Scope
- C1350.1.1 Design as per site conditions, supply, erection, testing & commissioning of Grid tied roof top Solar PV Power systems in the office Building and power house building.
- C1350.1.2 A Grid Tied Solar Rooftop Photovoltaic (SPV) power plant consists of SPV array, Module Mounting Structure, Power Conditioning Unit (PCU) consisting of Maximum Power Point Tracker (MPPT), Inverter, and Controls & Protections, interconnect cables, Junction boxes, Distribution boxes and switches. PV Array is mounted on a suitable structure. Grid tied SPV system should be designed with necessary features to supplement the grid power during day time. Components and parts used in the SPV power plants should conform to the BIS or IEC or international specifications, wherever such specifications are available and applicable.

- C1350.2 Solar Photovoltaic Module
- C1350.2.1 The PV modules used must qualify to the latest edition of IEC PV module qualification test or equivalent BIS standards Crystalline Silicon Solar Cell Modules IEC 61215/IS14286. In addition, the modules must conform to IEC 61730 Part-1 - requirements for construction & Part 2 – requirements for testing, for safety qualification or equivalent IS.
- C1350.2.2 PV modules shall be suitable to mount in highly corrosive atmosphere throughout their lifetime, they must qualify to IEC 61701.
- C1350.2.3 The total solar PV array capacity should not be less than allocated capacity (kWp) and should comprise of solar crystalline modules of minimum 300 Wp and above wattage. Module capacity less than minimum 300 watts shall not be accepted.
- C1350.2.4 Adequate protective devices against surges at the PV module shall be provided. Low voltage drop bypass diodes shall be provided.
- C1350.2.5 PV modules must be tested and approved by one of the IEC authorized test centres.
- C1350.2.6 The module frame shall be made of corrosion resistant materials, preferably having anodized aluminium.
- C1350.2.7 The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary by more than 2 (two) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
- C1350.2.8 The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP-65 rated.
- C1350.2.9 I-V curves at STC should be provided by the supplier.
- C1350.2.10 Modules deployed must use a RF identification tag
- C1350.3 Mounting Structure
- C1350.3.1 Hot dip galvanized MS mounting structures may be used for mounting the modules / panels / arrays. Minimum thickness of galvanization should be at least 120 microns.
- C1350.3.2 Each structure should have angle of inclination as per the site conditions to take maximum insolation.
- C1350.3.3 The Mounting structure shall be so designed to withstand the speed for the wind zone of the location where a PV system is proposed to be installed.
- C1350.3.4 The mounting structure steel shall be as per latest IS 2062: 1992 and galvanization of the mounting structure shall be in compliance of latest IS 4759.
- C1350.3.5 Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts.

- C1350.3.6 The fasteners used should be made up of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels.
- C1350.3.7 Regarding civil structures the contractor need to take care of the load bearing capacity of the roof and need arrange suitable structures based on the quality of roof.
- C1350.3.8 The minimum clearance of the structure from the roof level should be 300 mm.
- C1350.4 Junction Boxes
- C1350.4.1 The junction boxes are to be provided in the PV array for termination of connecting cables. The J. Boxes (JBs) shall be made of GRP / FRP / Powder Coated Aluminium /cast aluminium alloy with full dust, water & vermin proof arrangement. All wires / cables must be terminated through cable lugs. The JB's shall be such that input & output termination can be made through suitable cable glands.
- C1350.4.2 Copper bus bars / terminal blocks housed in the junction box with suitable termination threads Conforming to IP65 standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry. Single / double compression cable glands. Provision of earthing. It should be placed at 5 feet height or above for ease of accessibility.
- C1350.4.3 Each Junction Box shall have High quality Suitable capacity Metal Oxide Varistors (MOVs) / SPDs, suitable Reverse Blocking Diodes. The Junction Boxes shall have suitable arrangement monitoring and disconnection for each of the groups.
- C1350.4.4 Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.
- C1350.4.5 All fuses shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.
- C1350.5 DC Distribution Board
- C1350.5.1 DC Distribution panel to receive the DC output from the array field.
- C1350.5.2 DCDB shall be of dust & vermin proof conform to IP 65 protection. The bus bars are made of copper of desired size. Suitable capacity MCBs/MCCB shall be provided for controlling the DC power output to the PCU along with necessary surge arrestors
- C1350.6 AC Distribution Board
- C1350.6.1 AC Distribution Board (ACDB) shall control the AC power from PCU/ inverter and should have necessary surge arrestors. All switches and the circuit breakers, connectors should conform to IEC 60947, part I, II and III/ IS 60947 part I, II and III.
- C1350.6.2 All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz
- C1350.7 PCU / Inverter

C1350.7.1 As SPV array produce direct current electricity, it is necessary to convert this direct current into alternating current and adjust the voltage levels to match the grid voltage. Conversion shall be achieved using an electronic Inverter and the associated control and protection devices. All these components of the system are termed the “Power Conditioning Unit (PCU)”. In addition, the PCU shall also house MPPT (Maximum Power Point Tracker), an interface between Solar PV array & the Inverter, to the power conditioning unit/inverter should also be DG set interactive. If necessary. Inverter output should be compatible with the grid frequency. Typical technical features of the inverter shall be as follows:

Switching devices	IGBT/MOSFET
Control	Microprocessor /DSP
Nominal AC output voltage and frequency	415V, 3 Phase, 50 Hz (In case single phase inverters are offered, suitable arrangement for balancing the phases must be made.)
Output frequency	50 Hz
Grid frequency Synchronization range	+ 3 Hz or more
Ambient temperature considered	-20 °C to 50 °C
Humidity	95 % Non-condensing
Protection of Enclosure	IP-20(Minimum) for indoor. IP-65(Minimum) for outdoor.
No-load losses	Less than 1% of rated power
Inverter efficiency(minimum)	>93% (In case of 10 kW or above with inbuilt galvanic isolation) >97% (In case of 10 KW or above without in-built galvanic isolation)
Inverter efficiency (minimum)	> 90% (In case of less than 10 kW)

THD	< 3%
PF	> 0.9

- C1350.7.2 Three phase PCU/ inverter shall be used with each power plant system (10kW and/or above) but in case of less than 10kW single phase inverter can be used.
- C1350.7.3 PCU / inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.
- C1350.7.4 The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.
- C1350.7.5 Built-in meter and data logger to monitor plant performance through external computer shall be provided.
- C1350.7.6 Anti-islanding (Protection against Islanding of grid): The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.
- C1350.7.7 In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer. If Isolation Transformer is not incorporated with PCU/Inverter, there shall be a separate Isolation Transformer of suitable rating provided at the output side of PCU/PCU units for capacity more than 100 kW.
- C1350.7.8 The PCU/ inverter generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to the utility services should follow the latest CEA (Technical Standards for Connectivity Distribution Generation Resources) Guidelines.
- C1350.7.9 The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068-2 (1,2,14,30)/ Equivalent BIS Std.
- C1350.7.10 The MPPT units environmental testing should qualify IEC 60068-2 (1, 2, 14, 30)/ Equivalent BIS std. The junction boxes/ enclosures should be IP 65 (for outdoor)/ IP 54 (indoor) and as per IEC 529 specifications.
- C1350.7.11 The PCU / inverters should be tested from the MNRE approved test centres / NABL / BIS / IEC accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses.

- C1350.8 Integration of PV power with Grid
- C1350.8.1 The output power from SPV would be fed to the inverters which converts DC produced by SPV array to AC and feeds it into the main electricity grid after synchronization. In case of grid failure, or low or high voltage, solar PV system shall be out of synchronization and shall be disconnected from the grid. Once the DG set comes into service, PV system shall again be synchronized with DG supply and load requirement would be met to the extent of availability of power. 4 pole isolation of inverter output with respect to the grid/ DG power connection need to be provided.
- C1350.9 Data Acquisition System/ Plant Monitoring
- C1350.9.1 Data Acquisition System shall be provided for each of the solar PV plant
- C1350.9.2 Data Logging Provision for plant control and monitoring, time and date stamped system data logs for analysis with the high quality, suitable PC. Metering and Instrumentation for display of systems parameters and status indication to be provided.
- C1350.9.3 Temperature: Temperature probes for recording the Solar panel temperature and/or ambient temperature to be provided complete with readouts integrated with the data logging system.
- C1350.9.4 Solar and Electrical parameters are accessible via the operating interface display in real time separately for each solar power plant.
- C1350.9.5 All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and read on the digital front panel at any time) and logging facility (the current values, previous values for up to a month and the average values) should be made available for energy auditing through the internal microprocessor and should be read on the digital front panel.
- C1350.9.6 PV array energy production: Digital Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided. Energy meter along with CT/PT should be of 0.5 accuracy class
- C1350.9.7 Computerized DC String/Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box or separately.
- C1350.9.8 String and array DC Voltage, Current and Power, Inverter AC output voltage and current (All 3 phases and lines), AC power (Active, Reactive and Apparent), Power Factor and AC energy (All 3 phases and cumulative) and frequency shall be monitored.
- C1350.9.9 Computerized AC energy monitoring shall be in addition to the digital AC energy meter.
- C1350.9.10 The data shall be recorded in a common work sheet chronologically date wise. The data file shall be MS Excel compatible. The data shall be represented in both tabular and graphical form.
- C1350.9.11 All instantaneous data shall be shown on the computer screen.
- C1350.9.12 Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.

- C1350.9.13 Provision for instantaneous Internet monitoring and download of historical data shall be also incorporated.
- C1350.9.14 Remote Server and Software for centralized Internet monitoring system shall be also provided for download and analysis of cumulative data of all the plants and the data of the solar radiation and temperature monitoring system.
- C1350.9.14.1 Ambient / Solar PV module back surface temperature shall be also monitored on continuous basis.
- C1350.9.15 Simultaneous monitoring of DC and AC electrical voltage, current, power, energy and other data of the plant for correlation with solar and environment data shall be provided.
- C1350.10 Cables
- C1350.10.1 Cables of appropriate size to be used in the system shall have the following characteristics:
- C1350.10.2 Shall meet IEC 60227/IS 694, IEC 60502/IS1554 standards
- C1350.10.3 Temp. Range: -10°C to $+80^{\circ}\text{C}$.
- C1350.10.4 Voltage rating 660/1000V
- C1350.10.5 Excellent resistance to heat, cold, water, oil, abrasion, UV radiation
- C1350.11 Flexible
- C1350.11.1 Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire solar system to the minimum (2%)
- C1350.11.2 For the DC cabling, XLPE or, XLPO insulated and sheathed, UV stabilized single core multi-stranded flexible copper cables shall be used; Multi-core cables shall not be used.
- C1350.11.3 For the AC cabling, PVC or, XLPE insulated and PVC sheathed single or, multi-core multi-stranded flexible copper cables shall be used; Outdoor AC cables shall have a UV-stabilized outer sheath.
- C1350.11.4 The cables (as per IS) should be insulated with a special grade PVC compound formulated for outdoor use. Outer sheath of cables shall be electron beam cross-linked XLPO type and black in colour.
- C1350.11.5 The DC cables from the SPV module array shall run through a UV stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm.
- C1350.11.6 Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers.

- C1350.11.7 All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm; the minimum DC cable size shall be 4.0 mm² copper; the minimum AC cable size shall be 4.0 mm² copper. In three phase systems, the size of the neutral wire size shall be equal to the size of the phase wires.
- C1350.11.8 Cable Routing / Marking: All cable/wires are to be routed in a GI cable tray and suitably tagged and marked with proper manner by good quality ferule or by other means so that the cable easily identified. In addition, cable drum no. / Batch no. to be embossed/ printed at every one meter.
- C1350.11.9 Cable Jacket should also be electron beam cross-linked XLPO, flame retardant, UV resistant and black in colour.
- C1350.11.10 All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, salt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. DC cables used from solar modules to array junction box shall be solar grade copper (Cu) with XLPO insulation and rated for 1.1kV as per relevant standards only.
- C1350.11.11 The ratings given are approximate. Eol holder to indicate size and length as per system design requirement. All the cables required for the plant shall be provided by the Eol holder. Any change in cabling sizes if desired by the Eol holder shall be approved after citing appropriate reasons. All cable schedules/ layout drawings shall be approved prior to installation.
- C1350.11.12 Multi Strand, Annealed high conductivity copper conductor PVC type 'A' pressure extruded insulation or XLPE insulation. Overall PVC/XLPE insulation for UV protection Armoured cable for underground laying. All cable trays including covers to be provided. All cables conform to latest edition of IEC/ equivalent BIS Standards as specified below: BoS item / component Standard Description Standard Number Cables General Test and Measuring Methods, PVC/XLPE insulated cables for working Voltage up to and including 1100 V, UV resistant for outdoor installation IS /IEC 69947.
- C1350.11.13 The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%.
- C1350.11.14 The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%.
- C1350.12 Earthing and lightning protection
- C1350.12.1 The system should be provided with all necessary protections like earthing, Lightning etc.as per Indian and international standards.

C1351 TECHNICAL SPECIFICATION-INSTALLATION OF EQUIPMENTS

- C1351.1 Scope
- C1351.1.1 This specification covers the Engineering requirements for erection/installation, testing and commissioning of equipment/items and its associated works.
- C1351.2 Standards

C1351.2.1 Erection, testing and commissioning of the equipments covered shall be done as per standard codes of practice and shall comply with requirements of following Indian Standards and other relevant standards, Indian Electricity Rules and acts and also to the regulations that are in force at the place of installation.

IS: 1255 : Code of practice for installation and maintenance of power cables Upto and including 33 kV rating.

IS : 5216 : Guide for safety procedures and practices in Electrical work.

IS : 100118 : Code of practice for selection, installation and maintenance for Switchgear and control gear-Part-III Installation.

IS : 13408 : Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining application of explosives processing and manufacture).

IS : 3043/87: Code of practice for installation and maintenance of earthing of installation.

C1351.3 Reference

C1351.3.1 Following documents shall be read in conjunction with this specification

- (i) Scope of work and requirements
- (ii) Engineering Specification and Data sheet of General requirements of Electrical system.

C1351.4 General conditions for Installation of Equipment

C1351.4.1 The erection/installation, testing and commissioning shall be carried out in accordance with specification, data sheets, drawings, manufacturer's recommendations, and relevant standards or as directed by Employer. Requirements regarding erection/installation, testing and commissioning of switchboards, cables, etc, are generally explained here in. It is the responsibility of the contractor to supply all equipment, items, accessories, materials, tools, tackles, transporting, and lifting vehicles, consumables etc. required for unpacking, checking, transportation, storage, safe custody, installation, erection, testing, commissioning, return of unused equipment/items which are supplied from Employer's stores and handing over of the installation to the entire satisfaction of Employer.

- C1351.4.2 The erection scope shall include supply of all hard wares and accessories such as bolts, nuts, washers, gaskets, cable termination accessories, lugs, paint, primer, sand, etc. required for completeness of the work. All consumable materials such as insulation, tape, cleaning and paint brushes, welding electrodes, rust preventive materials, jute, cotton waste, hack saw blades, bolts, nuts, inhibitive grease, fuel, lubricants, etc, and any other material required in carrying out the work but not for incorporation in to the permanent work, shall also be included in the scope of contractor.
- C1351.4.3 The equipment/items to be erected shall be handled with care by experienced workers under the guidance of the competent supervisor. Proper handling and transporting equipments are to be used and dragging is to be avoided.
- C1351.4.4 The equipment/items supplied by the Employer, shall normally be kept at their stores. The contractor shall inspect these items at the stores by unpacking the containers, if necessary. Responsibility of safe custody of materials after delivery and till handing over shall rest with the contractor. Unused materials and containers shall be returned to the stores. The items supplied by the Employer shall be transported from the point of storage to the point of erection / installation using proper capacity transporting vehicles. The scope shall include unpacking the containers, assembling parts, fixing loose items, components, etc. Materials supplied by the contractor or issued by the Employer shall be given suitable protection against weather, dust and vermin. In storage places, equipments shall be placed over wooden sleepers to keep them above ground. Before carrying out erection/installation works of any item, proper care regarding levelling, alignment, access to working parts, facilities for removing the items for repair, statutory clearance, etc. shall be taken.
- C1351.4.5 Foundation bolts, nuts, lock nuts, washers, etc. will normally be supplied by the equipment supplier. Any further requirement of these items shall be under the scope of contractor. The equipment shall be installed on the foundation bolts firmly such that there will not be any vibration during operations. For mounting of equipment/items on the walls/ columns / supports, suitable MS/GI brackets shall be fixed/grouted.
- C1351.4.6 Electrical connections shall be done with great care using spring washers, bimetallic strips, conducting grease, etc. wherever required to ensure good contact without creating undue stresses. Copper bus bar joints shall be made after tinning the contact area. Supply of all required accessories or electrical connections shall be included in the contractor's scope. Discrepancies if any found between drawings/statutory requirements and actual conditions at the site, shall be immediately brought to the attention of Employers representative. If any modification is found required in the writing or to suit site condition the same shall be carried out as per the instruction of the Employer-In- Charge without any extra cost.
- C1351.4.7 All equipments under erection shall be kept properly cleaned and free of dust, vermin, moisture, etc. After erection, it shall be ensure that non-foreign materials, tools or tackles are left in the equipment. All unused cable entries, cutouts, etc. shall be sealed properly. For hazardous area, blanking plugs suitable for the area classification applicable shall be used.

- C1351.4.8 All tests shall be carried out in the presence of Employer's representative and test shall be recorded on an approved proforma duly certified. The records of all tests shall be submitted to the purchaser's representatives. All interconnected wiring shall be checked thoroughly for correct connection with the wiring and schematic drawings of the manufacturer and the drawings supplied by Employer before energizing.
- C1351.4.9 All power and bus bar connection shall also be thoroughly inspected and checked for connections, foreign materials, tightness, etc. before energizing the equipment All components within the main equipment shall be tested for proper performance and correct operation before commissioning the equipment.
- C1351.4.10 All labelling shall be checked for correctness. All nuts, bolts, clamps, joints, connections, etc. shall be checked for tightness and tightened wherever required. All moving parts shall be checked for its correct movement and proper lubrication. Apply lubrication wherever required. All equipment containing liquid shall be checked for correct quantity filling and all gaskets, walls, etc, shall be checked for leak proof. Oil filling, if found required, shall be done with dry and clean oil. Gaskets shall be replaced if found required. It shall be ensured that all CT leads are loaded or shorted prior to testing and commissioning. Insulation tests shall be carried on all electrical devices, whether specifically mentioned or not, as per this work after properly cleaning these devices.
- C1351.4.11 All the relays and its settings after commissioning shall be furnished to Employer detailing relay type number, panel number etc. In case of any component of an equipment supplied by the Employer is found to faulty/unsuitable, the same shall be replaced by the new one issued by Employer. All relays, before installation, the rating, range and auxiliary supply voltages for the relay should be checked against drawings/schematic/schedule.
- C1351.5 Civil and structural works
- C1351.5.1 Miscellaneous civil works associated with the erection/installation such as excavation, dewatering and refilling of earth work for earth pits and cable trench, chipping, grouting, small cutting, etc, on floors/walls/columns/structures and bringing back the same to original finish, grouting of supports, providing suitable fixing arrangements for cables, push button stations, DBs etc,. shall be included in the rates quoted for erection of the respective items, unless specifically excluded in the Schedule of Items of WorkII. All structural works associated with cabling, earthing, equipment erection and supporting arrangements shall be included in the scope of the contractor. All the welding and cutting works shall be carried out by certified welders. Painting shall be done on all MS materials provided, by the contractor such as base channels, frames, supports, pedestals, cable trays/racks/risers, enclosures, boxes, conduits, chequered plates, etc. Before painting, the surface should be thoroughly scraped and cleaned to remove dust, grease, plaster or any other foreign materials. It is the responsibility of the contractor to supply and install all the required materials for painting including paint. Cement concrete footing shall be provided for, cable trays/racks/risers, pedestals, supports, etc. Footing shall be provided using 1 : 2 : 4 PCC with 20mm broken stone. It is responsibility of the contractor to supply and install all materials such as river sand, reinforcement rods, 20mm broken

stone, etc. without any extra cost to Employer. All concrete works and grouting shall be cured for a minimum period of 48 hours.

- C1351.5.2 Chipping, grouting, etc as recommended shall be done for completion and installation work on the finished floor, wall, roof, etc. It is the responsibility of the contractor to supply all necessary materials and to bring the disturbed surface to the original finish. Touch painting of scratches found on equipment, other painted metallic surfaces, galvanised, etc. associated with this work is also included in the scope of contractor without any extra cost. Base steel structures shall be painted with 2 coats of epoxy primer and 2 coats of epoxy paint.
- C1351.6 Standard requirements for testing and commissioning
- C1351.6.1 The standard requirements for testing and commissioning are furnished below.
- C1351.6.2 All tests shall be carried out in the presence of Employer's representative and tests shall be recorded on an approved format duly certified. The records of all tests shall be submitted to the purchaser's representative.
- C1351.6.3 All interconnected wiring shall be checked thoroughly for correct connections with the wiring and schematic drawings of the manufacturer before energizing. All Power and bus bar connections shall also be thoroughly inspected and checked for correctness, foreign materials, tightness, etc. before energising the equipment.
- C1351.6.4 All components within the main equipment shall be tested for proper performance and correct operation before commissioning the equipment. All labelling and nameplates shall be checked for correctness. All nuts, bolts, clamps, joints, connections, etc shall be checked for tightness and tightened wherever required. All moving parts shall be checked for its correct movement and proper lubrication. Apply lubrication wherever required. All equipment containing liquid shall be checked for correct quantity filling and all gaskets, valves, etc., shall be checked for leak proof ness. Oil filling if found required shall be done with dry and clean oil. Gaskets shall be replaced if found required. The condition of the oil shall be tested in accordance with IS-335.
- C1351.7 Electrical Interface Requirement
- C1351.7.1 The contractor shall be responsible to ensure that the various E&M systems supplied are properly interfaced and integrated with that of others throughout the contract period. The contractor shall liaise and coordinating with other contractors of other systems to mutually agree the protocols to be used for all necessary data exchange.

C1351.8 Mode of measurement- Electrical Items

C1351.8.1 The Works shall be measured, as prescribed in the specification of work, notwithstanding any general or local custom, except where otherwise specifically described or prescribed in the Contract. Wherever not specifically mentioned in the Contract, the mode of measurement as prescribed in the relevant IS codes shall be applicable and binding to the Contract. Only the latest editions of all the codes of practices including all latest official amendments and revisions shall be applicable.

C1351.9 List of Approved Makes

S. No.	Equipment / Component	Preferred Makes
1.	Packaged Substation with 11kV panel and transformer	Lucy, ABB, Siemens, Unipower, Intrans
2.	LT Panel	CPRI/NABL certified as per IEC-61439 panel manufacturer with components of approved makes
3.	Distribution Boards	L&T, Siemens, Schneider, ABB, Legrand, Hagger
4.	Distribution Transformer	ABB, Intrans, Unipower, Voltamp, GE, CGL, KEL
5.	HT Power cable	Universal, NICCO, CCI, Havells, Polycab, Torrent, KEI
6.	LT Power cables	CCI, NICCO, KEI, Polycab, Universal, Havells, , Finolex, RPG, TRACO, Bonton, Apar
7.	660/1100 volt grade stranded unsheathed wire with copper conductor	Finolex , Polycab, TRACO, RR Kabel, Lapp Kabel, KEI, V Guard
8.	Cable Glands/Lugs	Jaisons, Dowells, Gripwell, SMF, HMI, LappKabel, Denson, Multipressings, Yamuna Gasses, Raychem, 3M, Hex, Comet
9.	Cable Trays	Indiana, Venus, Steelite, Rico Steel, Profab Engg, Sumip, Ercon
10.	LT Capacitor Bank	L&T, Epcos, ABB, Shreem, Sprague, Schneider
11.	Automatic Power Factor Correction Control Relay	Beluk, ABB, Epcos
12.	Battery	Exide, Amara Raja, HBL
13.	Diesel Engine	Cummins, Kohler, kirloskar, Volvo, Mitsubishi
14.	Alternator	Stamford, Leroysoner, Crompton

S. No.	Equipment / Component	Preferred Makes
		Greaves, kirloskar
15.	Lighting fixture (LED)	Bajaj, Philips, Crompton, lighting Technologies, Wipro, Osram
16.	LED Chip	CREE, Philips, Osram, Nichia
17.	High mast	Bajaj, Crompton, Philips, GE, WIPRO
18.	Street Light Poles	Unique Poles, K lite, Bajaj, Metal Coats, Schreder
19.	Modular Switches & Sockets, Boxes, bell push, fan regulator etc.	Crab Tree (Athena), MK India (Blenz), Legrand (myrius), Wipro (Northwest), Kolors (krest), ABB (Cheiron), Schneider
20.	GI Conduit with accessories	BEC, AKG, SENCO, Jindal
21.	MCCB	Siemens, L&T, ABB, Schneider, Legrand
22.	ACB	Siemens, L&T, ABB, Schneider, Legrand
23.	SDFU, Isolator, SFCOS	L&T, Siemens, Schnieder, ABB
24.	MCB / ELCB / RCB / MPCB	Siemens, L & T, Schneider, ABB, Hagger, Legrand, Mitsubishi
25.	Fuse/Link	Siemens, L&T, Schneider, ABB
26.	Contactors	Siemens, L&T, ABB, Schneider, C&S, BCH
27.	Indicating Lamps / Push buttons	Siemens, Schneider, Teknic, L&T, BCH, C&S
28.	Push button stations	Siemens, Schneider, Teknic, L&T, BCH, C&S
29.	Meters(digital) MFM	Schneider, L&T, Secure, ABB, Siemens, Socomec, Rishab, Elmeasure
30.	Voltmeter / Ammeter / PF Meter / Frequency Meter/ KWH Meter	AE, MECO, L&T, Rishab, Toyo, Mennekes
31.	TOD meter	L&T, Secure
32.	Selector Switch	L&T, Siemens, Schneider, Kaycee, Salzer, C&S, BCH
33.	Relays	L&T, Siemens, ABB, GE, Schneider, Alstom, C&S
34.	Timer	Siemens, L&T, BCH, Schneider, ABB, C&S
35.	Terminal Blocks	Elmex , Connect Well
36.	Panel Suppression System	Firetrace, Supremex, Ansul, Ceasefire, Safex, Chemgaurd
37.	Current Transformer/ Potential Transformer	Kappa, CGL, Indus, Intrans
38.	Industrial Plugs & Sockets	Legrand, Mennekes, ABB, Scame

S. No.	Equipment / Component	Preferred Makes
39.	Welding Sockets	B&C, BCH
40.	Exhaust Fan	Almonard, Crompton, Khaitan, Usha
41.	Ceiling fan	Crompton Greaves, Polar, Usha, Khaithan, Kulirma, Orient
42.	Occupancy Sensor	Schneider, Theban, Helvar, Osram, Honeywell
43.	PVC Conduit and accessories	Precision, LappKabel, Balco, Clipsal
44.	Cable Termination Kits & Straight Through Joints	Raychem, M-Seal (3M)
45.	UPS	APC, Eaton, Emerson, Socomec, GE, Consul, Reilo, Numeric, Legrand
46.	Chemical earthing	OBO, Dehn, CAPE, Excel
47.	Lightning Arrester	Dehn, OBO Bettermann, JMV LPS, CAPE
48.	110 KV/11 KV Power Transformer	ABB, AREVA, SIEMENS, SCHNEIDER, VOLTAMP, BHEL, TELK
49.	110 KV SF6 Circuit Breaker	ABB, AREVA, SIEMENS
50.	Potential and Current Transformers	MEHRU, ITC, ABB, TELK
51.	110 KV Isolator	ELPRO, GR Power, PR Engg., G.K.Electricals, Electrolite
52.	Lightning Arrestor	WS, ELPRO, OBLUM, LAMCO
53.	Insulators	WS, MODERN, BIRLA NGK, IEC, Jayashree
54.	Conductor/ Bus	INDAL, HINDALCO, Lumino, Omega cables.
55.	11 kV RMU Unit	Siemens, Schneider, Lucy, ABB
56.	11 kV VCB Unit	ABB, Siemens, Areva, Schneider

C1351.9.1 The above makes are the approved makes. However, if any equivalent make which successful bidder tends to supply differs from the above, the same has to be submitted to consultant/client for approval.

VOLUME-II
SECTION - 7A
SCOPE OF WORK

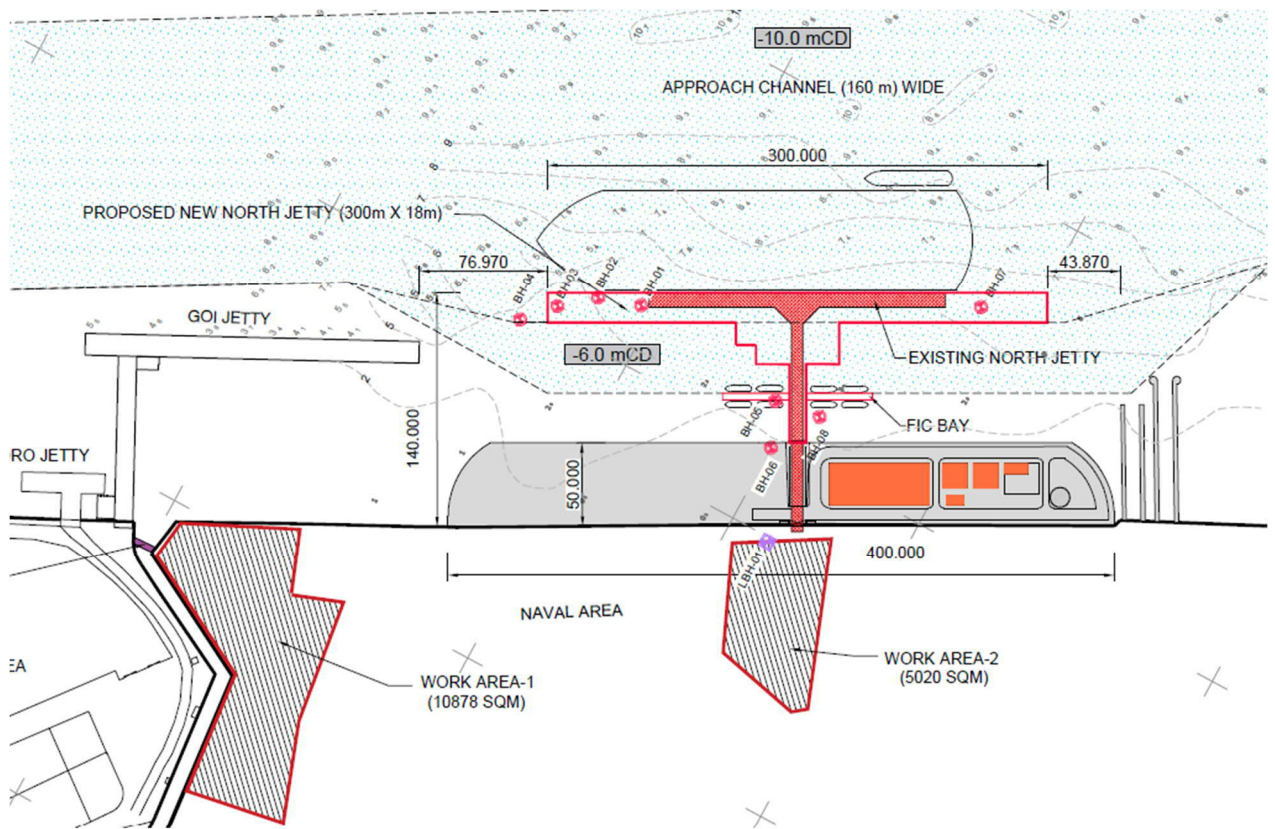
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7A100 GENERAL INFORMATION

7A101.1 Southern Naval Command (SNC) headquarters at Kochi have two jetties, North Jetty and South Jetty, which are utilized for berthing of ships of Indian Navy and Coast Guard. The existing North Jetty which was constructed during the period of 1948-1950, is now insufficient in size to cater to the increased requirement of berthing space and therefore, it is proposed to be demolished and re-constructed as a modern jetty to meet the Navy’s future requirements. Indian Navy (IN) has entrusted the “Re-construction of North Jetty at Naval Base, Kochi” including construction of associated facilities to Cochin Port Trust (CoPT) on Deposit Work basis.

The Key Plan of the proposed facilities is indicated in **Figure 1.1**.



CoPT has appointed AECOM for providing the Project Management Services for the Project, the scope of which includes assistance in the Tendering Process for the selection of EPC Contractor.

7A200 GENERAL SITE DATA

7A201 TIDAL LEVELS

7A201.1 Cochin experiences semi diurnal tides. The tidal levels as per Naval Hydrographic Chart No.2004 are as follow:

Tidal Datum	Elevation (m, CD)
Highest Astronomical Tide (HAT)	+1.30m
Highest High-Water Level (HHWL)	+1.20m
Mean High Water Spring (MHWS)	+0.92m
Mean Low Water Spring (MLWS)	+0.80m
Mean Sea Level (MSL)	+0.582m
Mean High Water Neap (MHWN)	+0.60m
Mean Low Water Neap (MLWN)	+0.30m
Lowest Low Water Level	+0.20m
Lowest Astronomical Tide (LAT)	-0.20m

7A201.2 The above levels are with respect to Cochin Port's Chart Datum which is 0.582 m below the Mean Sea Level. Tides in the area are semidiurnal type with an average tide range of 0.6 m.

7A202 WAVE DATA

7A202.1 Wave action inside the Ernakulam Channel is insignificant because of narrow entrance to Cochin Port between Vypeen and Fort Cochin and the configuration of the land. Generally calm conditions prevail throughout the year except during the times of extreme wind action.

7A203 CURRENT DATA

7A203.1 The currents along the coast of Cochin consists of tide, wave and wind induced components. As per observations, the maximum current velocities at the Cochin Gut during the non-monsoon periods is of the order of 3 knots, which could increase to as high as 5.5 knots during the monsoon periods. Inside the Ernakulam Channel, the current velocities are low, of the order of 0.5 knots only, with directions varying at different locations.

7A204 WIND DATA

7A204.1 The wind speed and wind direction are determined by the season and by the daily temperature differences between land and sea. The predominant wind direction during the monsoon period, i.e., from June to September is west to south-west and the effect of land breeze is not dominant during this period.

7A204.2 During the non-monsoon periods, the predominant wind direction is from north-east during the morning and west during the evening, which shows influence of land breeze. The maximum wind speed observed was of the order of 112 Km/hr from WSW direction.

7A205 TEMPERATURE, HUMIDITY AND RAINFALL

7A205.1 Temperature

7A205.1.1 Temperature at Kochi varies from about 23° C to 33° C with no appreciable seasonal variations. The highest temperatures are recorded in the months of March to May. The average monthly maximum and minimum temperatures recorded at IMD station Kochi is presented below.

Month	Temperature (° C)	
	Maximum	Minimum
January	31.9	23.0
February	32.0	24.2
March	32.6	25.5
April	33.0	25.9
May	32.4	25.7
June	30.3	24.2
July	29.6	23.8
August	29.5	24.0
September	30.2	24.2
October	30.7	24.1
November	31.3	24.1
December	31.9	23.2
Mean	31.3	24.3

Source: Climatological Tables (1981-2010), IMD

7A205.2 **Humidity**

7A205.2.1 The humidity is high all through the year. It is approximately 75% in the winter months and around 90% during the monsoon period. The average monthly relative humidity data recorded at Kochi IMD station is given below.

Month	Relative Humidity (%)	
	At 8.30 hrs	At 17.30 hrs
January	75	61
February	79	65
March	79	68
April	79	70
May	82	73
June	90	82
July	91	83
August	90	82
September	87	79
October	86	77
November	82	72
December	76	64
Average	83	73

Source: Climatological Tables (1981-2010), IMD

7A205.3 **Rainfall**

7A205.3.1 The average annual rainfall is reported as 3014.8 mm, and most of it is received in the period from May to October under the influence of south-west monsoons. June and July are the wettest months of the year, accounting for more than 50% of the annual rainfall. On an average, there are 124.1 rainy days in a year. The average monthly rainfall and rainy days recorded at IMD station Kochi is summarized below.

Month	Rainfall (mm)	No. of Rainy days
January	24.3	1.1
February	27.1	1.2
March	45.0	2.6
April	113.1	6.9
May	284.5	11.0
June	700.3	23.0
July	575.5	22.8
August	378.8	19.0
September	310.3	13.4
October	366.6	14.2
November	150.4	7.2
December	39.0	1.8
Total	3014.8	124.1

Source: Climatological Tables (1981-2010), IMD

7A206 SEISMIC CONDITIONS

7A206.1 The Project Site (Cochin) falls in Zone III, “Moderate” seismic intensity, with an associated Zone factor (Z) of 0.16 as per IS 1893 (Part 1): 2002 Table 2 and Annex E. Response reduction factor for RCC structures shall be 3.0 as per Table 7 of IS 1893-2002.

7A207 TOPOGRAPHIC INFORMATION

7A207.1 Topographic survey has been conducted at site which indicates that the ground levels at the proposed reclamation site broadly vary from +2.0 m CD to -2.0 CD. The extract of Topographic map is shown in the Drawing **60614746-DWG-TD-0000-PL-1002**.

7A208 GEOTECHNICAL INFORMATION

7A208.1 The geotechnical investigations at the location of the jetty, approach trestle and the proposed reclamation area have been conducted. The site investigation report is presented in Section 11. The investigation report and the drawings are only for the information of the Tenderer.

7A300 SCOPE OF WORK

7A301 GENERAL

7A301.1 The Employer's Requirements are that the Contractor shall carry out the Engineering, Design, Procurement of materials & labour and Construction / installation of all the items listed along with associated works including testing and commissioning as outlined in this Tender Document. For this purpose, the Tenderer shall conduct all necessary field tests and surveys to satisfy / verify himself regarding the correctness of the data furnished vis-à-vis actual condition. No claim whatsoever will be entertained for any variation between the actual site condition met with during the execution of the Work and those indicated in the Tender Document.

7A302 ITEMS TO BE COVERED UNDER THIS TENDER

7A302.1 The entire Scope of Work of the Contractor for this Tender is split into various groups for the purpose of monitoring. The broad items of works covered under each group are listed below:

7A302.2 Group A – Demolition of Existing Jetty

Demolishing the existing jetty including mooring dolphin and Crushing the demolished material for re-use as reclamation fill or road subgrade.

7A302.3 Group B – Berth, Approach Trestle and FIC Bay

- (a) Berth, Approach Trestle and FIC bays
- (b) Jetty fixtures like fenders, bollards, safety ladders, mooring rings, rubbing strip, handrails (RCC), etc., as required.
- (c) Crane rails, anchoring devices, jack-up points, end buffer stops, trailing cable groove, its protection system and its junction pit, etc., as required.
- (d) Various inserts for the utilities.
- (e) Utility ducts for services, hatch covers, louvers for ventilation openings.
- (f) Seawater Pump House for firefighting with separate diesel tank for storing diesel required for 6 hour operation of diesel pump.

7A302.4 Group C – Reclamation and Ground improvement

- (a) Vertical wall (sheet pile or touch pile or pile slab) with concrete capping
- (b) Reclamation filling
- (c) Compaction and ground improvement by suitable measures
- (d) Mooring facilities / bollards along the waterfront.

7A302.5 Group D –Buildings

- (a) Power House
- (b) Office cum Store building (G + 2)

- (c) DG Room
- (d) Underground Water Sump and Pump House for potable water and fire fighting of land side facilities
- (e) Compressor House
- (f) Elevated Water Tank
- (g) Guard Room
- (h) Watch Towers – 2 Nos
- (i) Sheds for Storage of Oxygen and Acetylene Cylinders.

7A302.6 Group E – Electrical Distribution System

- (a) 110kV Single Bay switchyard in complete including Power transformer, SF6 CB, Surge arrestor, etc., with tapping power supply from the existing bay of MES substation including separate metering bay as per KSEB standard.
- (b) 11kV indoor panel boards and related power distribution systems in the MES substation.
- (c) Drawing 11kV power supply from the new 110kV MES substation located at an approx. distance of 3.75 km from the proposed North Jetty Power House to the Power House and other Buildings/Structures in the Reclamation Area and Berths.
- (d) Electrical equipment in the Power House and other Buildings/Structures in the Reclamation Area and Berths.
- (e) Lighting in the Reclamation Area and Berth, Trestle and FIC bays including lighting the service/utility ducts, underside berth and kerb (all LED).
- (f) Aviation lights for the High masts, Cranes etc.
- (g) Power supply to all the equipment, cranes, pumps, etc.
- (h) Backup power supply through DG sets (2 x 250 KVA minimum capacity with load management and synchronization panel)
- (i) Electrification inside the buildings including electrical fixtures
- (j) Air conditioning in Office cum Store building with VRF A.C. and in Power House Control Room with Split A.C.
- (k) SCADA system in the MES substation as well as North Jetty Substation and both SCADA systems to be integrated.
- (l) On-grid Roof Top Solar PV system above the Office cum Store building and Power House.

- (m) Civil works related to Electrical works such as Concrete cable trench, Insert plates, Foundation for Electrical items, Excavation and refilling for cable work, Hume pipes, Cable pull pits, Horizontal Direct Drilling (HDD) etc.

7A302.7 Group F – Rail Mounted Cranes

Providing Two Nos. Rail Mounted Tower Cranes of 50T lifting capacity at 10 m minimum radius and 10T lifting capacity at 50 m radius and with a height restriction of 47.22 m above MSL / 47.802 above Port Chart Datum.

7A302.8 Group G – Utilities and Other Infrastructure

- (a) Compound Wall
- (b) Entry Gate
- (c) Roads including Culverts
- (d) Surface Drainage
- (e) Sewerage system including packaged STP
- (f) Water Supply System
- (g) Compressed Air System
- (h) Oxy Acetylene System and Piping Distribution
- (i) Fire Fighting System – Freshwater as well as sea water, including Fire Detection System
- (j) Communication System comprising Telephone System, CCTV, Public Address System
- (k) Data Cables, Telephone cables, Sockets for Data and Telephone Network.
- (l) Miscellaneous Works including clearing and leveling of the entire Project Area
- (m) Provision for installation of fuel line and installation of other pipelines, cables, etc. in the utility ducts and providing cope points and pillar boxes in the berth and FIC bays
- (n) Ventilation System inside service galleries and buildings.

7A302.9 It is to be noted that the dredging shall be carried out through a separate tender floated by the Employer and the dredging shall commence after the completion of berth structure.

7A302.10 The Contractor shall submit warranty/guarantee cards or receipts of the various parts used in the Works. In this regard, the Contractor has to enter into agreement with the suppliers, who have to pass on the said warranty/right to the Employer. The Contractor shall submit warranty / guarantee effective from the date of commissioning of the Works.

- 7A302.11 The structures, equipment, system/sub-systems and components shall confirm in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous operation in a manner acceptable to the Employer and shall also be in line with the current practices for reliable and efficient functioning of facility.
- 7A302.12 In the event of conflict between requirements of any two clauses of the Specifications / Documents or requirements of different codes / standards specified, the more stringent requirement as per the interpretation of the Employer shall apply.
- 7A302.13 The Contractor while executing the Works shall follow good industry practice, which however shall meet the Employer's Requirements. The Contractor shall adhere to and honour the Conditions of Contract, in all respects.

7A303 DESCRIPTION OF CONTRACTOR'S SCOPE OF WORK

7A303.1 General

- 7A303.1.1 The Specifications provided in the Tender together with enclosed Scope Drawings outline the functional requirements and the operating characteristics which the structures/facilities must fulfill. Alternative technical features/designs other than those specified may be acceptable subject to meeting the functional requirements and the operating characteristics and has the approval of the Employer. In any case, the performance of the system/ equipment, if any delivered, shall be guaranteed in every detail by the Contractor. Overall dimensions (boundary dimensions) and functional requirements as specified shall be strictly adhered to. The Scope of Work detailed below is for overall understanding of the Works and does not absolve the Contractor from successful commissioning and operation of the Works with best available latest technology. Any item/equipment not listed but required for completion of the Works shall be considered as included in the Scope of the Contractor.
- 7A303.1.2 The Contractor shall be deemed to have examined the Site and familiarized himself with all existing Site conditions. He shall accept the Site in the existing condition at the time of Award of Contract.

7A304 DETAILED SCOPE OF WORK UNDER THIS TENDER

- 7A304.1 The Detailed Scope of Work under this Package is given below. This shall be read in conjunction with the Tender Drawings provided as part of the Package:

7A304.2 Group A – Demolition of Existing Jetty

The Scope shall include the following:

- (a) Demolishing the entire superstructure of existing jetty, approach trestle and mooring dolphin

- (b) Demolishing / cutting off the piles of jetty and approach trestle upto the existing bed level or upto 0.0 m CD whichever is lower except the seaside two rows of piles of jetty, which shall be cut upto proposed dredged level i.e. -10 m CD.
- (c) Extracting/ pulling out all the piles of mooring dolphin
- (d) Crushing the demolished material for reuse either as reclamation fill or road subgrade, after retrieving the reinforcement, and disposing off the unusable waste materials.

7A304.3 **Group B – Berth, Approach Trestle and FIC Bay**

The Scope shall include the following:

- (a) Jetty of size 300m x 18 m, two parking areas of size 20mx 25m and a seawater intake Pump House of size 10 m x 12 m towards the rear side of the jetty
- (b) Two (2) FIC bays of size 40 m x 4 m each
- (c) Approach Trestle of size 72m x 10m
- (d) Berth fixtures like fenders, bollards, safety ladders, mooring rings, rubbing strip, RCC handrails etc., as required.
- (e) Crane rails, anchoring devices, jack-up points, end buffer stops, trailing cable groove with automatic cover & its protection system and its junction pit, etc., as required.
- (f) Various inserts for the utilities.
- (g) Utility ducts for services, hatch covers, louvers for ventilation openings. The arrangement and layout of services within utility ducts shall be subject to the approval of the Employer
- (h) Kerb and screed concrete (wearing course) with secondary reinforcement with high quality Polypropylene fibres and primary steel reinforcement, as required.
- (i) Suitable fenders adjacent to the ladders to avoid damage due to boats / vessels.

Berthing and mooring facilities shall be provided on both sides of Berth and FIC bay as per Specifications and Drawings. All the steel sections to be used in the marine works (Group B works) shall be of Stainless steel of grade SS316. Warranty of five (5) years for fenders and bollards shall be obtained and a bank guarantee in the format provided in the Tender Documents shall be submitted in this regard.

7A304.4 **Group C – Reclamation and Ground Improvement**

7A304.4.1 An area of about 20,000 sqm has to be reclaimed as per the layout and other details presented in the Scope Drawings. The Contractor shall provide a permanent vertical wall with concrete capping, for retaining the reclamation fill. Suitable ground improvement measures shall be adopted to improve the soil properties to ensure its meeting the design criteria. Mooring facilities / bollards are also to be provided along the waterfront, as required by the Employer. Layout of Reclamation area and concept scheme of ground improvement is shown in **Drawing 60614746-DWG-TD-0000-PL-1004 & 1005**.

7A304.5 **Group D – Buildings**

7A304.5.1 The buildings that shall be constructed as part of this Tender are given in **Table 3.1** below

Table 3.1: Buildings

S. No.	Building	Type	Staff Occupancy	Minimum Built Up Area (Sqm)
1.	Power House	Single Storied Building with Mezzanine floor	5 persons	2400 sqm
2.	Office cum Store building (G + 2)	Three Storied Building	50 persons	675 sqm
3.	DG Room	Single Storied Building	5 persons	225 sqm
4.	Pump House	Single Storied Building	-	85 sqm
5.	Compressor House	Single Storied Building	-	60 sqm
6.	Elevated Water Tank		-	30 m high with water storage capacity of 500 cum.
7.	Underground Water Sump		-	265 sqm, with water storage capacity of 1300 cum including 423 cum of fire water compartment
8.	Guard Room		10 persons	36 sqm
9.	Watch tower – 2		2 persons	16 sqm each

S. No.	Building	Type	Staff Occupancy	Minimum Built Up Area (Sqm)
	Nos.		each	
10.	Seawater Pump House		-	120 sqm
11.	Shed for Oxygen Cylinders		-	60 sqm
12.	Shed for Acetylene Cylinders		-	60 sqm

7A304.5.2 The buildings are to be provided with all provisions for power, lighting, ventilation, air conditioning, communication, water distribution, sanitary arrangements and architectural finishes, etc. in accordance with the Specifications and Drawings.

7A304.5.3 Suitable number of split type air-conditioners to be provided in the Power House Control Room. VRF type air-conditioners to be provided in the conference rooms and office rooms in the Office cum Store building.

7A304.5.4 Suitable provision to be kept in the watch towers for LMG stands. The layout of the tower shall be got approved from the Employer before starting the detailed design.

7A304.5.5 The minimum built-up area of each building shall be as specified in Table 3.1. However, the Contractor shall be required to build more area, in case it is required to meet the functional and design requirements.

7A304.5.6 The Contractor shall prepare architectural layouts for each building, meeting the requirements as set out in the Tender Document and submit to Employer. The detailed design of the buildings shall be taken up only after the Employer's acceptance of the final architectural scheme of the respective building.

7A304.6 **Group E – Electrical Distribution System**

The Scope shall include the following:

- (a) 110kV Single Bay switchyard in complete in the MES Substation located at an approximate distance of 3.75 km from the proposed North Jetty Power House including Isolator, Breaker, Current Transformer (CT), Potential Transformer (PT) / Capacitor Voltage Transformer (CVT), Lightning Arrester, 10/12.5MVA 110kV/11kV Transformer, Bus Bar system, Structural members, fencing, earthing system, metering and protection system, etc. The 11 KV panel shall be connected to the existing HT panel through 11 KV bus coupler. The SCADA system shall also be provided and integrated with the existing system.

- (b) 110KV metering bay as per KSEB standard with all measuring and control equipment.
- (c) Nitrogen purging system for the Power Transformers with control valves, control cables, piping & accessories etc.
- (d) Four 11kV feeders from new 110kV MES substation to feed the installed power load capacity of 9 MVA for the Power House to be located in the Reclamation Area.
- (e) Distribution of power supply to Jetty and other installations and auxiliaries through new Substation on different systems as below:
 - 415 V, 3- phase, 50 Hz
 - 380 V, 3- phase, 50 Hz
 - 440 V, 3- phase, 60 Hz with static frequency converter
 - 220 V, 1- phase, 50 Hz
 - 220 V DC Supply
- (f) Electrical equipment such as Transformers, Switchboards, Compressors, Capacitor Banks (APFC)/ Harmonic filters, Switchgear panels, Bus Couplers, Breakers, Isolators, Frequency Converter, Rectifiers, Lightning Arrestors, Pillar Boxes, Marine Grade Cope Points, Power And Control Cable, Cable Trays, Earthing System etc. in the Reclamation Area and Berth.
- (g) Sandwich Bus Duct from transformer secondary to panel board within the Substation wherever required. Bus duct is not allowed in the Service Gallery.
- (h) Control Room in the Power House with necessary arrangements for operating and monitoring the complete power supply system, Lighting in the Reclamation Area, Berth, Trestle and FIC Bay. Total 5 nos. High Masts of 30 m height shall be provided with sufficient luminaries along with the lighting poles to achieve the desired lux levels.
- (i) PLC and SCADA system in the MES Substation as well as in the proposed North Jetty Substation to monitor and control the power distribution system from control room. MES Substation SCADA and North Jetty Substation SCADA to be interfaced to access the important data in both the places.
- (j) Backup power supply of 500 kVA through DG sets (2 x 250 KVA minimum capacity with load management and synchronization panel)
- (k) Electrification inside the buildings including electrical fixtures (all LED)
- (l) Street and approach lighting in the Reclamation Area
- (m) Aviation lights for the High Masts, Cranes etc.
- (n) Power supply to all the equipment, cranes, pumps, etc.

- (o) Necessary lighting under deck, inside the Service Galleries and kerb lighting in the Berth, FIC Bays and Approach Trestle (all LED). Exhaust fans inside the Service Galleries.
- (p) Emergency lighting system with UPS backup to be provided in the Buildings (atleast of 20% of lighting load)
- (q) 100% UPS backup for all Extra Low Voltage services and Emergency lighting.
- (r) Battery chargers & DCDB
- (s) On-grid Roof Top Solar PV system to be provided in the roof top of the Office cum Store building as well as Power House building and the same to be interfaced with 415V power distribution system.
- (t) Providing Data cable, OFC cable & control cable between MES Substation North jetty Substation and other control system as per design requirement.
- (u) Approval for electrical installation from Central Electricity Authority (CEA) / any other statutory agency.
- (v) Electrical safety items as per requirement and anti-static painting on the flooring at Power House
- (w) Onsite training/Factory training for customer's operating staff for routine operation and maintenance procedures.
- (x) Essential spares, tools and tackles for the Electrical distribution system & providing list of recommended spares.
- (y) All the civil works which are required for Electrical installation will be in the Contractor's Scope. Construction of concrete cable trench from MES Substation to North Jetty Substation, providing cable trays on trench and HDD work, if required, also shall be in the Scope of the Contractor.
- (z) Design of foundation and providing foundation & insert plates, Base frames etc. for Electrical Equipment such as DG Set, Transformer, Panel Board, Feeder Pillar, Switch Yard Equipment, High Mast, Street Light pole etc.
- (aa) Diverting/removal of existing service lines which are fouling on the cable route, if any, shall be in the Contractor's Scope.

7A304.7 **Group F - Tower Cranes**

Two Nos. Rail Mounted Tower Cranes of 50 T lifting capacity at minimum 10 m radius and minimum 10 T lifting capacity at 50 m radius shall be provided at the Berth. The maximum height of the cranes during parking position shall be limited to 47.22 m above Mean Sea Level / 47.802 above Port Chart Datum.

7A304.8 Group G – Utilities and Other Infrastructure

7A304.8.1 The scope of work for various items under this group is detailed below:

7A304.9 Compound Wall

7A304.9.1 The compound wall shall be provided around the boundary of reclaimed land with RCC columns in fill with a brick masonry wall of 3.7 m high with barbed wire fencing 0.9 m high. The RCC columns shall not be spaced at more than 3 m. The approximate overall length of wall shall be 400 m. Suitable foundation system (either Pile foundation or Strip foundation) for the boundary wall shall be provided by the Contractor based on his design to satisfy the Design Criteria. Layout of the proposed boundary wall and Typical Details are shown in **Drawing 60614746-DWG-TD-0000-PL-3012**.

7A304.10 Roads including Culverts

7A304.10.1 Internal roads shall be provided as per the layout shown in Scope drawings. Any Culverts required at the crossing of the drains and drainage system shall be provided. Culverts shall be of RCC Box type. Gratings with bar spacing of 200 mm x 200 mm shall be provided at culvert opening to backwaters.

7A304.10.2 Details of Roads as planned have been provided herein below:

Road Type	Overall Width	Carriageway Width	Width of Paved Shoulders on either side of Carriageway	Approximate length
Type R1	11 m	10 m	0.5 m	40 m
Type R2	8 m	7 m	0.5 m	500 m
Type R3	4.5 m	3.5 m	0.5 m	70 m
Type R4	Paved area (about 1600 sq.m)			

7A304.10.3 Layout of Roads and Typical Cross Sections are shown in **Drawing 60614746-DWG-TD-0000-PL-3001 & 3014**.

7A304.11 Surface Drainage

7A304.11.1 A drainage system for carrying the storm water run-off from the area as shown in the Scope Drawings is to be designed and provided. The design rainfall intensity shall be taken as 50 mm/hr for the purpose of design of drainage system at Site. Typical Layout for Drainage is shown in **Drawing 60614746-DWG-TD-0000-PL-4012**.

7A304.12 Sewerage

7A304.12.1 Sewerage system for whole of the Works is to be designed and provided. The system shall comprise of pipelines for collection of the sewage from Buildings, packaged STP of 5.0 KLD capacity, pipeline from the STP to storm water drain as shown in **Drawing 60614746-DWG-TD-0000-PL-3016**.

7A304.13 **Water Supply System**

7A304.13.1 Water supply distribution system for the supply of potable water to buildings and ships is to be provided. The system shall comprise of underground water sump, elevated water tank, water pumps, pipelines, cope points at the Berth and FIC bays at the maximum intervals as shown in Scope Drawings. All water supply pipelines shall be of CPVC. Layout of water supply system is shown in **Drawing 60614746-DWG-TD-0000-PL-4010**.

7A304.14 **Compressed Air System**

7A304.14.1 The compressed air requirement at North Jetty is 7 bars for LP. To meet this requirement, the following shall be provided:

- Air Compressors of suitable size in the Compressor Room
- Pipeline of required size and type to carry the Compressed Air from the Compressor Room to the Jetty.
- Compressed Air tappings are kept at minimum 75 m intervals on both sides of the Jetty.
- Ball valves of suitable size to regulate the air flow

7A304.14.2 Layout of Compressed Air Supply system is shown in **Drawing 60614746-DWG-TD-0000-PL-4002 & 4003**

7A304.15 **Oxy-Acetylene System**

7A304.15.1 The oxy-acetylene system shall be provided and taken to the Jetty to meet the following minimum requirement of gases for welding, for which the following shall be provided by the Contractor:

- The Contractor shall provide separate sheds for storage of oxygen and acetylene gas and discharge facility, which shall be designed and installed by a specialist company.
- 20 cylinders, each of minimum 7 cum. capacity of Acetylene and Oxygen each are to be installed, testing & commissioning complete
- A dry pipe sprinkler system within the acetylene storage compound in accordance with NFPA 13. The sprinkler system shall be connected to fire and gas detection system which shall initiate the sprinkler system in the event of a fire within the compound or close by. This fire protection system including equipment, pipework, valves, controls etc shall be designed to meet the safety requirements.
- All electrical equipment and wiring within in the Storage Sheds shall be with flame proof fittings.
- Pipeline of required size and type to carry the gases to the Jetty are to be provided.

- Tappings at intervals as shown in the drawings and as required by the Employer during execution are to be provided.
- All connections, valves, gauges ball valves, accessories, fixtures, fittings etc complete are to be provided.

7A304.16 **Fire Fighting System**

7A304.16.1 The fire-fighting system at the Reclamation Area shall comprise of fire hydrant system with hydrants provided at intervals of 60 m along the Reclamation Area and buildings. Each hydrant connection shall be provided with suitable length of hose and nozzle to permit effective operation. The fire water pumps shall be provided in the underground water sump. The overall layout is shown in **Drawing 60614746-DWG-TD-0000-PL-4004**.

7A304.16.2 For the fire fighting system at the Jetty, Approach and FIC Bays and for fire water supply to ships, a Pump house shall be built near the Jetty to draw sea water for supply to ships for use in their internal firefighting system and also for fire fighting in the Jetty, Approach and FIC bays. Main electric and standby diesel pumps shall be provided in the Pump House along with jockey pump. 100% backup for electrical pump has to be provided over and above a standby diesel pump. Fire Hydrants shall be provided in the Berth and FIC bays at a maximum spacing shown in the **Drawing 60614746-DWG-TD-0000-PL-4004**.

7A304.16.3 The fire fighting system shall also comprise of the Fire Detection System and Alarm System, Sprinkler System, Portable Fire Extinguishers and, Public Address System, as specified in the Employer's Requirements.

7A304.17 **Fuel Supply**

This shall comprise of the following:

1. Provision for installation of fuel line in the utility ducts from the supply point
2. Provision for isolation of fuel pipeline at the crossing to prevent any fire hazard
3. Provision for taking fuel pipe lines to the other side of the Approach Trestle in the Reclaimed Area, as required.
4. Provision for providing cope points in the Berth and FIC bays at a minimum of 50 m interval in Jetty and 20 m interval in FIC Bay.

7A304.18 **CCTV and Communication System**

These works shall comprise of the following:

1. Providing CCTV network in the Project Areas with suitable number of cameras to ensure surveillance through the monitoring of the Project Areas, as well as create a tamperproof record for post event analysis, as per the Tender specifications.

2. To provide EPABX system of 50 lines and instruments in the onshore area and Jetty at the locations to be provided by the Employer during execution.

7A304.19 Miscellaneous works

These Works shall comprise of the following:

1. Lift with carrying capacity of minimum 8 persons in Office Building;
2. Electrically operated EOT Crane in Power House;
3. Manual Hoist with chain pulley block in Pump Houses;
4. Clearing of Work Areas provided to the Contractor to enable their use for the Project;
5. Barricading the periphery of the Work Areas by a minimum 8 m high fencing to prevent disturbance to the adjoining residential and operational areas.
6. Establishment of Site Office and other facilities for the Employer/ Indian Navy as per the Tender Specifications;
7. Providing vehicles for Employer/Indian Navy's Project Management Team.
8. Providing CCTV during execution for surveillance and Project Monitoring, intercom system with walkie talkie, mobile phones etc.;
9. Rerouting of the existing utilities, if required. The existing roads, green belt, all existing structures etc., if disturbed during re-routing, shall be reinstated to their original state / position;
10. Environmental Monitoring and Reporting as required in the Environmental/ CRZ Clearance obtained for the Project, during the Project execution as per the Tender Specifications; and
11. Demolition of any permanent/temporary structures and restoration of the Site after completion of the Works, and before demobilization.

7A305 THIRD PARTY CERTIFICATION

- 7A305.1 All the design calculations and reports shall be duly vetted by reputed Third Party Agencies of international repute such as IIT Madras or IIT Mumbai , IIT Kanpur or IIT Delhi and accordingly, a certificate shall be enclosed along with each submission for review and approval of the Employer.
- 7A305.2 Structural Stability Certificate for the structures certified by the above said Third Party shall be submitted prior to Taking Over of the Works.
- 7A305.3 All major Mechanical items of work executed for the Project shall be certified by renowned Classification Agencies at the cost of the Contractor. The Contractor shall appoint any one / more among the list of agencies viz. IRS, ABS, LRS, DNV or BV as Classification Society.

- 7A305.4 For the works where Third party inspection is required/ envisaged, the Third party inspection agency shall be selected by the Employer from the list of minimum 3 agencies suggested by the Contractor. The Employer may engage another Third party inspection agency also and the decision of the Third party inspection agency engaged by the Employer shall be final.
- 7A305.5 For the Tower Cranes, the Employer will appoint Third Party Inspection Agency separately. The Contractor shall provide all necessary support for enabling the inspection and certification by TPIA.
- 7A305.6 Mere certification from the Third Party Agencies shall not relieve the Contractor from fulfilling his contractual obligations. The Contractor is responsible for the successful completion of the Works and the Works shall serve the required design life.

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SECTION 7B

DESIGN CRITERIA

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7B. DESIGN CRITERIA / INTENT

7B.1 General

The Employer has provided concept details in the Tender Document to provide the Contractor with sufficient information so as to clearly understand the Employer's intent, goals and objectives in execution of the works. The Contractor will be required to adopt the general concepts, as provided, and expand and develop the same to produce complete, thorough, comprehensive and high quality designs, working drawings, and specifications for review and approval of the Employer.

While developing the complete and final designs and specifications, the Contractor shall review the concept details, planning and specifications provided by the Employer to become intimately familiar and fully understand the Employer's intent and also to identify betterments or improvements, if any, which may be considered, and incorporated, to better achieve the Employer's goals and objectives in providing highly efficient and functional facilities. These betterments, if any, shall be submitted by the Contractor for review and subsequent approval by the Employer prior to the commencement of final design.

7B.2 Main Jetty, FIC Bay and Approach Trestle

7B.2.1 Codes and Standards

The codes and standards stated here below or elsewhere shall be the latest editions. All materials, testing, design and execution shall be in conformity with these codes and standards unless otherwise stated in the specifications. Indian Standards shall generally be followed. In case, any work or item is not covered by the Indian Standards, following standards shall be adopted in order of preference.

1. British Standards
2. American Standards
3. General Standards

Table 7.1 provides a list of the primary codes and guidelines which will be used for the structural design of the marine structures. A consistent set of standards will be used for each element of the works, with supplementary codes and guidelines used where additional requirements are needed.

Table 7.1 Codes and Standards

IS 456: 2000	Plain and Reinforced Concrete – Code of Practice, Fourth Revision
IS 800: 2007	General Construction in Steel – Code of Practice, Third Revision
IS 875 (Part 1): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 1, Dead Loads – Unit Weight of Building Materials and Stored Materials, Second Revision Incorporating Amendment No.1, Reaffirmed 1997
IS 875 (Part 2): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 2, Imposed Loads, Second Revision, Reaffirmed 1997
IS 875 (Part 3): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 3, Wind Loads, Second Revision, Reaffirmed 1997
IS 1893 :1984	Criteria for Earthquake Resistant Design of Structures
IS 1893 (Part 1): 2002	Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings, Fifth Revision
IS 4651 (Part II): 1989	Code of Practice for Planning and Design of Ports and Harbours, Part II Earth Pressures
IS 4651 (Part III): 1974	Code of Practice for Planning and Design of Ports and Harbours, Part III Loading, First Revision, Reaffirmed 2012

IS 4651 (Part IV): 2014	Code of Practice for Planning and Design of Ports and Harbours, Part IV, General Design Considerations, Second Revision, Reaffirmed 2005
IS 4651(Part V): 1980	Code for Planning and Design of Ports and Harbours Part V, Layout and Functional Requirements, Reaffirmed 2012
IS 2911 (Part 1/Sec2)	Code of Practice for Design and Construction of Bored Cast In situ Piles
IS 2911 (Part 4)	Load Test On Piles
IS 13920 :1993	Ductile detailing of reinforced concrete structures subjected to seismic forces
IS 6403 :1981	Code of Practice for Determination of Bearing Capacity of Shallow Foundations
BS 6349; Part 4 : 1994	British Standard for Maritime Structures, Part 4: Code of Practice for Design of Fendering and Mooring Systems
IRC: 6-2010	Standard Specifications and Code of Practice for Road Bridges, Section II: Loads and Stresses, Fifth Revision
EN 1998	Eurocode 8 : Design of structures for Earthquake resistance
PIANC	PIANC Guidelines for the Design of Fender System, 2002

7B.2.2 Design Life

The permanent works shall be designed and constructed to give the following design lives:

- Main Jetty, FIC Bay and Approach Trestle - 50 years
- Fenders, Bollards and ladders - 15 years

Above design lives are defined as a period within which the asset will continue to be serviceable for design loads without collapse.

7B.2.3 Design Vessel Sizes

The design vessel sizes range and characteristics to be considered for the design of main jetty and FIC bay are provided in **Table 7.2**.

Table 7.2 Design Vessels for Main Jetty and FIC Bay

Name of Vessel	Standard Load (Ton)	Full Load (Ton)	Length Overall (m)	Beam (m)	Draft (m)
Vikrant (IAC)	34000	41000	262.5	62.45 (Flared) 32.40 (at WL)	8.8
INS Viraat Aircraft Carrier	23900	28700	226.9	52.0 (Flared) 27.4 (at WL)	8.8
Delhi Class Destroyer	6700	6900	163.0	17.4	6.5
R-Class Destroyer	3950	4974	147.0	15.8	5.0
Training Vessel (TIR)	-	3200	105.9	13.2	4.8
Offshore Petrol Vessel	-	1890	101.1	11.5	
Survey Ship	1929	1960	87.8	12.8	3.3
Fuel Barge	-	1000	53.0	9.1	4.6

Name of Vessel	Standard Load (Ton)	Full Load (Ton)	Length Overall (m)	Beam (m)	Draft (m)
Fast Interceptor Craft (FIC)	-	90	16.3	3.8	0.8

Jetty / Side	Vessel to be berthed
Main Jetty - Sea side	All vessels
Main Jetty - Lee side	Upto 3200 T Naval Vessels
FIC bays - Both sides	FIC

7B.2.4 Salient Levels

Deck level	:	(+) 4.85 m CD
Highest High-Water Level (HHWL)	:	(+) 1.20 m CD
Mean High Water Spring (MHWS)	:	(+) 0.92 m CD
Mean Sea Level (MSL)	:	(+) 0.582 m CD
Lowest Low Water Level (LLWL)	:	(+) 0.20 m CD
Design dredged level at seaside of jetty	:	(-) 10.00 m CD
Minimum Design dredged level at rear side of jetty	:	(-) 6.00 m CD
Design dredged level at FIC bay	:	(-) 6.00 m CD

7B.2.5 Marine Growth

An allowance in dimension of the submerged structures due to marine growth shall be taken in to account. For design 50 mm thick marine growth shall be added to the dimension of any submerged element.

7B.2.6 Loads

7B.2.6.1 Dead Load

The dead loads shall be assessed based upon the volume of the material using the following densities:

Concrete (Reinforced) : 25.00 kN/m³

Concrete (Plain) : 24.00 kN/m³

Sea water : 10.25 kN/m³

Steel : 78.50 kN/m³

The dead load due to the following shall be used in design:

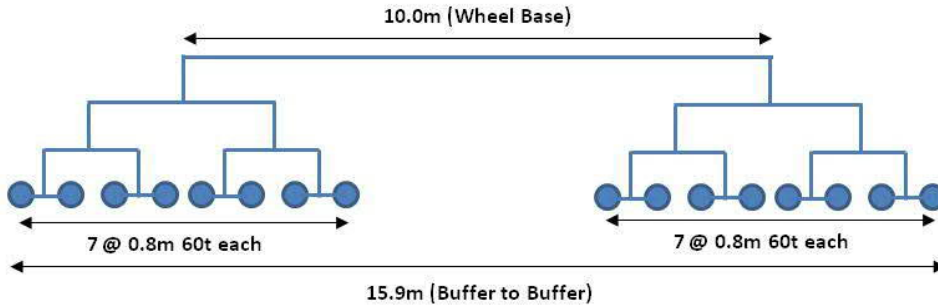
- Substructure and Superstructure
- Superimposed Dead load
- Miscellaneous items such as fenders, services, ladder, railing, light poles, etc.

7B.2.6.2 Live Load

The live load to be considered for Main jetty, Approach and FIC bay shall be 38 kN/m² or IRC Class AA, whichever governs. Impact for IRC vehicular load shall be as per IRC 6.

7B.2.6.3 Equipment loads

The Jetty shall be designed for the loads of two rail mounted Tower cranes of 50 T capacity at minimum 10 m radius and 10 T capacity at 50 m radius. Principal dimensions of the proposed cranes shall be considered as follows:



Crane Span : 10 m No. of Wheels : 8 wheels per corner

Each wheel load : 60 T Wheel spacing : 0.8 m

Impact factor shall be considered as 25% of wheel load.

Note: The jetty shall be designed for the above crane loads as a minimum. In case the loads due to cranes to be installed by the Contractor governs the design, the same shall be considered.

7B.2.6.4 Wind Load

Wind loads shall be considered in accordance with IS 875: Part3.

Basic wind speed of 20.0 m/s and 39 m/s shall be considered for operating (service) condition and survival (extreme) condition respectively.

7B.2.6.5 Seismic Load

Seismic force shall be calculated according to IS 1893. As per IS code, Cochin is under Zone III. Following factors shall be considered in seismic force calculations:

Zone factor, Z = 0.16

Importance factor, I = 1.5

Response reduction factor, R = 3.0

7B.2.6.6 Current Load

Water current force corresponding to current speed of 1 m/s in operating as well as storm conditions shall be considered. An allowance in dimension of the submerged structures due to marine growth shall be taken into account.

7B.2.6.7 Berthing Load

Berthing Energy

Berthing loads shall be determined in accordance with IS: 4651 for the design vessels. Approach velocities, angles of approach and Abnormal Berthing Factor for different type of vessels shall be considered as per table given below.

Table 7.3 Parameters for calculation of Berthing Energy

S. No.	Type of Vessel	Displacement Tonnage (T)	Approach Velocity (m/s)	Angle of Approach (Degrees)	Abnormal Berthing Factor
1.	Vikrant (IAC)	41,000	0.15	10	1.5
2.	INS Viraat Aircraft Carrier	28,700	0.15	10	1.5
3.	Delhi Class Destroyer	6,900	0.20	20	1.5
4.	R-Class Destroyer	4,974	0.25	20	2.0
5.	Training Vessel (TIR)	3,200	0.25	20	2.0
6.	Offshore Petrol Vessel	1,890	0.25	20	2.0
7.	Survey Ship	1,960	0.25	20	2.0
8.	Fuel Barge	1,000	0.25	20	2.0
9.	Fast Interceptor Craft (FIC)	90	0.25	20	2.0

Both normal and abnormal berthing conditions shall be considered.

For calculation of berthing energies, the parameters of ship specific berthing pontoons used (where applicable) and typical cross sections of the warship/s in the areas of the pontoons/fenders may be sought from the employer, for the various combinations of ships to be berthed. These calculations and associated details are to be submitted in support of the berthing schemes and associated fenders recommended by the contractor.

Fendering System

A suitable fender system shall be designed to absorb the design berthing energy of the vessel and to keep the vessel's hull pressure below the limit of 20 T/m².

Fender spacing needs to be designed such that it prevents contact between the ship's hull and the face of the berth as well as providing a sufficient number of fenders while the ship is at berth on the jetty. The fender spacing shall not exceed 15% of the length of the smallest vessel to be berthed at the pier (BS:6349-4, 2014). Additionally, in order to prevent contact of the hull with the jetty at impact, a maximum spacing between fenders on the jetty shall be checked. The number and type of fenders and spacing as shown below shall be followed as a minimum requirement.

Jetty / Side	Vessel berthed	Type of Fender	Size of Fender Dia x Length (mm)	Spacing of Fenders (m)
Main Jetty / Sea side	IAC Vikrant + Fuel Base	Pneumatic	2500 x 4000	16
		Arch	400 x 4000 long	4
Main Jetty / Lee side	Upto 3200 T Naval Vessels	Pneumatic	2000 x 3500	20 / 22
		Arch	400 x 4000 long	4
FIC bay / both sides	FIC	Arch	250	2.4

7B.2.6.8 Mooring Load

Mooring load under operating condition shall be calculated as per IS: 4651 (Part 3).
Mooring Pull under operating condition shall be applied at two Bollard points.

Following capacity bollards shall be provided at main jetty and FIC bay. Hence, the jetties shall be designed for full capacity of the bollard in extreme conditions.

Jetty / Side	Vessel berthed	Bollard capacity (T)	Spacing of Bollards (m)
Main Jetty / Sea side	IAC Vikrant + Fuel Base	90	20.0
Main Jetty / Lee side	Upto 3200 T Naval Vessels	40	10.0
FIC bay / both sides	FIC	2	8.0
Along reclamation water front	Small crafts	0.5	10

7B.2.6.9 Temperature Loads

Design temperature rise and fall of $\pm 5^{\circ}$ C shall be considered for analysis of structures.

The co-efficient of thermal expansion for concrete shall be considered as 12×10^{-6} / $^{\circ}$ C.

7B.2.6.10 Shrinkage and Creep Stresses

In addition to temperature fall of 5° C, equivalent temperature fall of 8.5° C shall be considered towards shrinkage.

Creep coefficient shall be considered as 1.1 for calculating long term effects.

7B.2.6.11 Load Combinations

The load combinations shall be in accordance with IS:4561 (Part 4):2014. Load combinations for assessing serviceability limit states and collapse limit states are provided in Table 7.4 and Table 7.5, respectively.

Table 7.4 Load Combination-Serviceability Limit States

Primary Loads	DL + SIDL	LL	CL	CL (non- op)	WL (op)	WC	BL	ML	S	T	EQ
Transient Short term crack width	1.0	1.0	-	1.1	1.0	1.0	-	-	1.0	-	-
	1.0	1.0	-	1.1	1.0	1.0	1.0	-	1.0	-	-
	1.0	-	-	1.1	1.0	1.0	1.0	-	1.0	-	-
	1.0	1.0	1.1	-	1.0	1.0	-	1.0	1.0	-	-
	1.0	-	-	1.1	1.0	1.0	-	1.0	1.0	-	-
Deflection at expansion joint	1.0	1.0	1.1	-	1.0	1.0	-	-	1.0	-	1.0
	1.0	-	-	1.1	1.0	1.0	-	-	1.0	-	1.0
Sustained Long term crack width	1.0	0.5	-	1.0	1.0	1.0	-	-	1.0	1.0	-

Note: DL- Dead Load; SIDL- Superimposed dead load; LL - Uniform live load; CL(Op) - Operating Crane Load; CL(Non-Op)- Non-Operating crane load; WL(Op) - Operating wind load; WL(st) - Storm wind load; WC(Op) - Operating water current load; WC(st) - Water current load in storm conditions; BL- Berthing load; ML-Mooring load; T - Temperature variation; EQ - Earthquake load; S – Secondary stresses

Table 7.5 Load Combination-Collapse Limit States

Primary Loads	DL + SIDL	LL	CL	CL (Non-op)	WL (op)	WL (st)	WC	WC (st)	BL	BL (ab)	ML	ML (ext)	E Q	
ULS Combinations	1.5	1.5	-	1.5	1.0	-	1.2	-	-	-	-	-	-	
	1.5	-	-	1.5	1.0	-	1.2	-	-	-	-	-	-	
	1.5	1.5	-	1.5	1.0	-	1.2	-	1.5	-	-	-	-	
	1.5	-	-	1.5	1.0	-	1.2	-	1.5	-	-	-	-	
	1.5	1.5	1.5	-	1.0	-	1.2	-	-	-	1.5	-	-	
	1.5		1.5	-	1.0	-	1.2	-	-	-	1.5	-	-	
	1.2	1.2	-	1.2	1.0	-	1.0	-	-	1.0	-	-	-	
	1.2	-	-	1.2	1.0	-	1.0	-	-	1.0	-	-	-	
	1.2	1.2	-	1.2	1.0	-	1.0	-	-	-	-	1.0	-	
	1.2	-	-	1.2	1.0	-	1.0	-	-	-	-	1.0	-	
	1.2	1.2	-	1.2	1.0	-	1.0	-	-	-	-	-	1.2	
	1.2	-	-	1.2	1.0	-	1.0	-	-	-	-	-	1.2	
	1.5	-	-	-	1.0	-	1.0	-	-	-	-	-	-	1.5
	1.2	1.2	-	1.2	-	1.2	-	1.0	-	-	-	-	-	-
	1.2	-	-	1.2	-	1.2	-	1.0	-	-	-	-	-	-
1.2	1.2	1.2	-	1.0	-	1.0	-	-	-	-	-	-	-	

Primary Loads	DL + SIDL	LL	CL	CL (Non-op)	WL (op)	WL (st)	WC	WC (st)	BL	BL (ab)	ML	ML (ext)	E Q
	0.9	0.9	-	0.9	1.0		1.0	-	1.5	-	-	-	-
	0.9	-	-	0.9	1.0		1.0	-	1.5	-	-	-	-
	0.9	0.9	0.9	-	1.0		1.0	-	-	-	1.5	-	-
	0.9	-	0.9	-	1.0		1.0	-	-	-	1.5	-	-
	0.9	0.9	-	0.9	-	1.5	-	1.0	-	-	-	-	-
	0.9	-	-	0.9	-	1.5	-	1.0	-	-	-	-	-
	0.9	0.9	-	0.9	1.0	-	1.0	-	-	-	-	-	1.5
	0.9	-	-	0.9	1.0	-	1.0	-	-	-	-	-	1.5

Note: DL- Dead Load; SIDL- Superimposed dead load; LL - Uniform live load; CL(Op) - Operating Crane Load; CL(Non-Op)- Non-Operating crane load; WL(Op) - Operating wind load; WL(st) - Storm wind load; WC(Op) - Operating water current load; WC(st) - water current load in storm conditions; BL- Berthing load; BL(ab)- Abnormal Berthing load; ML-Mooring load; ML(ext) – Extreme Mooring load; T - Temperature variation; EQ - Earthquake load; S – Secondary stresses

7B.2.7 Materials

Material suggested for construction of new jetty structure and their specification is given in Table 7.6.

Table 7.6 Material Specifications

Structural Concrete	M-40
Levelling Concrete	M-15 of 100 mm thick
Reinforcement	Thermo-mechanically treated corrosion resistant steel of grade equivalent to Fe-500
Cement	Ordinary Portland Cement of minimum grade 53 as per IS:12269
Structural Steel	As per IS:2062 (Grade-A) with minimum thickness of 10 mm
Protective coating to structural steel	Minimum DFT of 240 micron after sand blasting to SA 2.5 grade

7B.2.8 Minimum Cover

Clear cover to any reinforcement shall be as mentioned here under but shall not be less than the diameter of such reinforcement.

Pile & Pile muffs : 75 mm

Beams : 50 mm

Slab : 50 mm

7B.2.9 Serviceability Checks

7B.2.9.1 Deflection Limits

The deflection for reinforced concrete structures shall conform to IS 456: 2000, Clause 23.2.

Deflection of Pile at deck level shall be restricted to L/350.

7B.2.9.2 Crack width Limits

Crack width of all the structural elements shall be calculated wherever necessary as per IS: 456. Crack width for reinforced concrete structures shall be as recommended in Table-3 of IS 4651: Part 4:2014 and presented in Table 7.7.

Table 7.7 Allowable Crack Width

S. No.	Exposure Zone	Crack Width Limit	
		Sustained Load	Transient Load
1.	Atmospheric Zone – Zone above HHWL	0.2	0.3
2.	Splash Zone – Zone between HHWL and LLWL	0.1	0.2
3.	Below splash Zone up to Bed level	0.2	0.3
4.	Below Bed level	0.3	0.3

Sustained Load = Long term load combinations for crack width

Transient Load = Short term load combinations for crack width

7B.3 Onshore Facilities

7B.3.1 Codes and Standards

The codes and standards stated here below or elsewhere in this document shall be the latest editions. All materials, testing, design and execution shall be in conformity with these codes and standards unless otherwise stated in these specifications. It is well understood that when a brand name is given for a material, the Contractor has the right to propose any equivalent material of any other brand for approval of the Employer / Engineer.

All works shall satisfy the requirement of latest relevant codes, standards and regulations for the works as per Tender. Indian Standards shall generally be followed. In case, any work or item is not covered by the Indian Standards, following standards shall be adopted in order of preference.

1. British Standards
2. American Standards
3. General Standards

Codes and standards covering the major part of the works are included in the Tender Document and some of them are listed below:

IS 456	Code of Practice for Plain and Reinforced Concrete
IS 1893	Criteria for Earthquake Resistant Design of Structures
IS 875	Code of Practice for Design Loads for Buildings and Structures – (Part 1 – 5)
IS 800	Code of Practice for General Construction in Steel
IS 2911	Code of Practice for Design & Construction of Pile Foundations
IS 3370	Code of Practice for Concrete Structures for the Storage of Liquids
IRC 37	Guideline for the Design of Flexible Pavements
IS 13920	Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces – Code of Practice
IS 4326	Earthquake Resistant Design & Construction of Buildings – Code of Practice
IRC 58	Guidelines for the Design of Plain Jointed Rigid Pavements for Highways
	National Building Code

Relevant codes for Utilities items like water supply, power supply, drainage, lighting as indicated in Specifications.

7B.3.2 Design Life

The permanent works shall be designed and constructed to give the following design lives:

- Reclamation Bund - 50 years
- Buildings - 50 years
- Pavements - 25 years
- Equipment - as per manufacturer's recommendations.

Above design lives are defined as a period within which the asset will continue to be serviceable for design loads without collapse subject to the regular inspection and preventive maintenance but not the major repairs and rebuilding.

7B.3.3 Reclamation and Ground Improvement

The onshore land for the project purpose shall be made available through reclamation. The top level of the area shall be kept as +2.0 m CD and shown in the tender drawings. A vertical wall is required to be provided for retaining the reclamation fill, in such a manner so that it could also provide a berthing facility for small crafts. The vertical wall shall be suitably designed to retain the reclamation fill under adverse environmental conditions and surcharge loading without any structural damage and settlement or deflections beyond permissible limits.

Reclaimed fill areas shall be treated by adequate ground improvement methods, as necessary, to provide adequate stability and bearing capacity to withstand a minimum live load of 3 T/sqm on the reclaimed land and to provide a firm foundation for construction of structures and to achieve the specified settlement criteria.

Slope stability analyses of the edge structures (vertical wall) shall be carried out to examine all possibilities including circular and non-circular failures using methods of analysis in accordance with the recommendations of BS 6031. The effects of earthquake loads shall be considered including the potential for liquefaction and softening.

In the absence of Indian Standard codified requirements for the design of embankments for seismic events, the Employer accepts the use of “IITK-GSDMA Guidelines for Seismic Design of Earth Dams and Embankments (2007)”. In adopting these guidelines, the Contractor shall adopt an Importance Factor (I) of 1.5.

Settlement analysis shall be undertaken to evaluate the elastic short term and long term settlements due to the Design Load. Wherever the improvement of clayey soils are necessary, in addition to achieving the required settlement limits, the settlement analysis shall demonstrate that at least 95% of the primary consolidation is complete before any ground treatment, if any is removed or is considered complete. In no case shall the ground treatment surcharge load be less than the Design Load. The amount of residual settlement shall be determined with appropriate software and shall include the calculation of creep as well as secondary compression and primary consolidation.

The Contractor shall submit calculations of the settlement effects of earthquake loading as well as calculations of the settlement effects due to static load effects.

As part of the Contractor's design, the selection of reclamation material, placement, ground improvement design and sequencing shall be undertaken. The Contractor shall be responsible for determining and addressing the issue of liquefaction.

7B.3.4 Buildings

The buildings shall be provided with adequate arrangements for plumbing, sanitary, electrical fittings, illumination, air-conditioning, water distribution etc. All buildings shall be provided with data cables, sockets for telephone and network and adequate space shall be kept for future cables. All structures shall be analysed as framed structure using STAAD Pro for the loads and their combinations. All designs of RCC structures shall be carried out by limit state method. Following minimum considerations shall be followed:

- Floor to floor height shall satisfy the bylaws of National Building Code.
- A 750 mm wide plinth protection shall be provided around each building.
- Finished floor level of building shall be 1000 mm above the finished ground level.

- All external walls shall be of 230 mm thick, all partition walls shall be minimum 115 mm thick with 1:4 cement mortar.
- All buildings shall be designed for allowing construction of an additional floor in future.

7B.3.4.1 Materials

- Cement shall be ordinary Portland cement of minimum grade 53 as per IS:8112.
- Grades of concrete shall be M-40 for Sub structure and M-30 for super structure.
- For watch towers' parapet wall, the grade of concrete shall be M-50
- Grade of steel shall be thermo-mechanically treated corrosion resistant steel Fe500
- Grade of structural steel shall be as per IS:2062 (Grade-A) with minimum thickness of 10 mm
- Protective coating to structural steel shall be minimum DFT of 240 micron after sand blasting to SA 2.5 grade
- Grade of Stainless Steel shall be SS 316.

7B.3.4.2 Minimum Cover

Clear cover to any reinforcement shall be as mentioned here under but shall not be less than the diameter of such reinforcement.

Table 7.8: Clear Cover for Buildings

Pile	75 mm
Top, bottom & side of footing (if any)	50 mm
Pedestal / column	
• Below ground	50 mm
• Above ground	40 mm
Beams	25 mm
Slab	20 mm
Face of walls & grade beam	50 mm (in contact with soil)
Face of walls not exposed to soil	25 mm(min.) or dia. of main bar

7B.3.4.3 Staircase

Minimum Clear Width	: 0.8 m
Tread Width	: Not less than 250 mm
Riser	: Not Greater than 180 mm

7B.3.4.4 Loads

7B.3.4.4.1 Dead Load

Dead loads shall include the weight of all structural and architectural components and other permanently applied external loads. The unit weight of all other materials shall satisfy the requirements of IS: 875.

7B.3.4.4.2 Environmental Load

- Wind
 - Basic Wind Speed in storm condition : 39 m/s
 - Basic Wind Speed in operating condition : 18 m/s
- Seismic
 - Zone factor : 0.16 (Corresponding to seismic zone III)
 - Importance factor : 1.50
 - Response reduction factor : 3

7B.3.4.4.3 Superimposed Load

Table 7.9: Live Loads on Buildings

Flat Roof	150 kg/m ² + Dust load of 50 kg/m ² hanging load for pipe shall be considered as 100 Kg/m ² and 50 Kg/m ² for electrical, ventilation & air conditioning (wherever applicable)
Non-accessible roof	75 kg/m ² + Dust load of 50 kg/m ²

7B.3.4.4.4 Equipment Load

Load due to elevator of about 8 passenger capacity shall be considered for design of Office building. The Substation building / Pumphouse shall be designed to accommodate anticipated static and dynamic loading from electrical equipment. Where the uniform floor live load adequately accounts for the equipment weight, the weight of such equipment as a dead load need not be considered. Manufacturer's technical specifications shall be followed for any other equipment loading considerations during detailed design stage

Impact Factor:

- For Manual monorail/Hoist design an impact factor of 1.20 shall be considered in design.
- For Electrical monorail/ Hoist design an impact factor of 1.25 shall be considered in design.

7B.3.4.4.5 Load Combinations

The load combinations shall be in accordance with IS:456 :2000 as given below.

- DL+ LL+ Equipment Load
- DL + LL +Equipment Load
- DL + LL + Equipment Load +WL
- DL + 0.5 LL + Equipment Load + Seismic Load
- 0.9*DL + W.L.
- 0.9*DL + Seismic Load.

Note:

- In addition, load due to earth pressure/surcharge shall be considered as per specific structures requirement

- Underground tank shall be checked for Uplift in empty condition. Minimum factor of safety against uplift shall be 1.2.

7B.3.4.4.6 Deflection Limits

For steel structures, conform to IS 800: 2007, Clause 5.6.1, Table 6

For reinforced concrete structures, conform to IS 456: 2000, Clause 23.2.

7B.3.4.4.7 Crack Width Limits

Crack width of all the structural elements shall be calculated wherever necessary as per IS: 456 and limiting Crack width for all structural components below ground and in contact with water shall be 0.2 mm and for structural elements above ground shall be 0.3 mm.

7B.3.5 Water Supply System

An underground water tank of 1000 cum capacity for potable water with an additional chamber of 500 cum capacity for firefighting shall be built on the reclaimed land to store water.

From the underground water tank, water shall be pumped to an overhead water tank of 12m dia. and 6m height located on reclaimed land, with a total height of about 30 m. Two electric driven water pumps of 114 cum/hr capacity each with 50 m head shall be provided in the pump room. There would be an option to either pump the water to the overhead tank or to the potable water hydrants directly.

The broad design parameters for water supply system are given below:

- Hydraulic design of the pipeline shall be using Hazen-Williams formula
- All pipelines shall be laid 1.2 m below ground
- The residual pressure in the pipeline at the farthest point shall be 2 kg/sq.cm
- The pumps shall be of centrifugal type.
- The ON/OFF system shall be provided for pumping potable water to buildings and vessels.
- All Manholes shall be provided with heavy duty ductile iron or cast-iron covers.

7B.3.6 Sewerage System

The toilets provided in the office cum store building as well as toilets at other locations shall be connected to a Sewage treatment plant (STP) of 5 KLD capacity to be provided by the Contractor. The design and laying of the pipelines shall be carried out as per the provision of relevant IS codes. The treatment process is planned to be based on MBBR technology.

Wastewater generated from toilets, bathrooms shall be collected via series of drains and shall be collected in sewage collection tank which shall be fully enclosed and covered with slab. Oil & grease trap shall be provided in collection tank. Collected sewage shall be treated before disposal. Quality of raw sewage will be as per table presented below. Treated sewage must meet the EIA and NGT norms before being discharged. Present guidelines for treated effluent for disposal are as under:

S. No.	Parameters	Raw Sewage	Treated Sewage	Unit
1	Flow	As per Scope		MLD
2	BOD ₅	250-300	<5	mg/l
3	COD	500-600	<50	mg/l
4	Suspended Solids	300-350	<5	mg/l
5	pH	6.5 – 8.5	6.5 – 8.5	
6	Total Kjeldahl nitrogen	60	As per applicable standards	mg/l
7	Ammonical Nitrogen	35-40	<2	mg/l
8	Total Nitrogen		<10	mg/l
9	Total Phosphorus	5 – 7	<1	mg/l

The successful bidder must obtain the latest EIA and NGT guidelines for the disposal of treated effluent. Any chemicals or consumables required will be supplied for a period up to DLP.

The design of the structural components shall be carried out either using Staad Pro or manually using standardized excel spreadsheets for the loads and their combinations. All designs of RCC structures shall be carried out by limit state method as per IS: 456 cracked section.

Foundation system shall be decided based on loading arrangement, load intensity and soil strata. Design of foundation at various levels shall be dependent up on the soil profile, which in turn shall be as per recommendation of soil investigation report. All foundations shall be designed as per limit state method of design.

7B.3.7 Fire Fighting System

A Hydrant based firefighting system has been proposed for the onshore area. The fire water hydrants shall be provided at suitable locations as per the codal requirements. The fire water shall be stored in one of the chambers of underground water tank having capacity of 500 cum. One electric driven fire water pump of suitable capacity (minimum 273 cum/hr) and one diesel driven standby pump of same capacity, with minimum 70 m head, shall be provided in the pump room of the underground water tank. One jockey pump of suitable capacity (minimum 35 cum/hr) shall also be provided in the pump room to maintain the pressure of 3.5 kg/cm² in the remotest hydrant. Fire alarm system shall be provided in service gallery as per NBC-2016. The sprinkler system shall be connected to the jockey pump. On triggering of the thermal sensor, the jockey pump shall start initially up to a certain required pressure after which the main electric fire pump will start. The design criteria for the sprinkler system is as per IS: 15105.

For fire fighting at jetty, FIC, approach trestle and to provide the fire water connection to the ships, the fire water hydrants at a spacing of 30 m along either side of main berth and at a spacing of about 20 m on either side of FIC bay shall be provided. The fire water shall be supplied through a sea water pump house proposed to be located on the rear side of the jetty. One electric driven fire water pump of suitable capacity (minimum 410 cum/hr) and standby electrical driven pump of same capacity is provided. Over and above one diesel driven standby pump of same capacity, with minimum 85 m head, shall also be provided in the pump room. One jockey pump of suitable capacity (minimum 50 cum/hr) shall also be provided in the pump room to maintain the pressure of 8 kg/cm² in the remotest hydrant. The jetty hydrants shall be

provided with international shore connection sockets to enable connection with the ships. The sprinkler system shall be provided all through the service gallery and shall receive fire water from the pump house.

Portable fire extinguishers shall be provided inside the buildings in key locations. Fire Extinguishers of 5 kg capacity, and medium Dry Chemical Powder (DCP) with standard accessories with minimum 2 Nos. for each building shall be provided.

Fire alarm system shall be provided in each building on the reclaimed in terminal area as per NBC-2016.

The sprinkler system shall be connected to the Fire protection system consisting of main pumps and jockey pump. On triggering of the thermal sensor, the jockey pump shall start initially up to a certain required pressure after which the main electric fire pump will start. The design criteria for the sprinkler system shall be as per IS: 15105.

Water level indicator in Fire water tank as well as the Fire pump status indicator/control shall be incorporated in the design. The level indicator shall control the solenoid valve to switch ON and switch OFF the required pumps.

7B.3.8 Ventilation System

The service gallery shall be used to run the pipes and the cable. The proper ventilation should be provided for the servicemen for maintenance and fresh air circulation inside the gallery. The service gallery shall be ventilated at 12 Air changes per hour. The wall mounted exhaust fans shall be provided at the outer wall toward sea for exhaust. The spacing between exhaust fan and fresh air louver shall be maintained at minimum 30 meter. The louver shall be weather proof type. The fan and louver shall be installed at a suitable height inside the gallery where these can be accessed easily for maintenance.

7B.3.9 Fire Detection System

Service gallery shall be provided with heat detection cable. The detection system shall consist of rate-of-rise heat detectors spaced out as per the manufacturer's instructions. Heat detectors shall be installed in accordance with IS2189. Activation of a heat detector would send a signal to the fire alarm system.

The manual fire alarm call points (MCP) require a maximum travel distance of 30m as per IS2189 §6.3.8.

The MCPs must be mounted 1.4m above the floor adjacent to a light source so that the MCPs are conspicuous. They shall be protected in a dust and moisture proof housing.

7B.3.10 Communication System

The following communication system have been envisaged:

- Telephone systems
- CCTV
- Public Address System
- EPABX System

A conduit system shall be provided to support communication systems.

7B.3.11 Service Gallery

All the utility services including fuel line will be carried in service gallery through pipelines and cables. Service gallery shall be provided with Fire Detection and Alarm system comprising of Smoke & Heat Detectors, Manual call points etc. Along the walls of the service gallery, exhaust fans at 30 m interval shall be provided for proper ventilation. Hatch covers of size 1 m x 1 m shall be provided at 30 m spacing along the length of the service gallery. Out of which 6-material hatch covers, 2 along the approach trestle and 4 on jetty, of size 1m x 2 m shall be provided. Service gallery shall have adequate space for installation of additional pipes / cables in future.

Cope points will be provided for typical ship-to-shore connections along the jetty and FIC Bays on each side for various services like electric supply, potable water supply, communication system, fuel etc.

7B.3.12 Internal Roads

Internal roads shall be designed with the provision of relevant IRC codes with the following minimum requirement as below:

Road Type	Overall Width	Carriageway Width	Width of Paved Shoulders on either side of Carriageway
Type R1	11 m	10 m	0.5 m
Type R2	8 m	7 m	0.5 m
Type R3	4.5 m	3.5 m	0.5 m

7B.3.12.1 Geometric Parameters

- Maximum longitudinal grade : 3.0%
- Cross slope : Unidirectional/ BiDirectional 1.5% for All Roads
- Maximum super elevation : 5%
- Sight Distance : Intermediate sight distance
- Turning Radius at junction : Min. 25 m
- Design Speed : 60 km/hr

7B.3.12.2 Pavement Design

- Traffic : 2 MSA
- Pavement type : Flexible

7B.3.12.3 Specification

- Flexible Pavement
- Embankment : Min. Density shall be 1.6 T/cum
- Sub grade : Min. CBR 8% and density 1.75 T/cum
- Granular Sub Base : Minimum 200 mm
- Granular Base : Minimum 250 mm
- Bituminous Surfacing
 - Binder course : Dense Bituminous Macadam

- Wearing course : Bituminous Concrete

The culverts required for the cross-drainage works shall be designed as per the IRC codes. The length of culvert shall be adequate to suit the size of roadway.

7B.3.13 Storm water Drainage

Storm water drainage system shall be designed and constructed to completely collect and dispose off the storm water. Drainage system will be based on open RCC channels with suitable openable RCC covers. At the road crossing the storm water drain shall have suitable culvert of R.C. Hume pipes. This shall be designed for Class A or Class AA IRC loading whichever is stringent. A suitable steel grillage structure shall be provided near outfall points so as to prevent entry of any unauthorized personnel through the culvert. Storm water drainage shall be designed with the following basic consideration:

- The design rainfall intensity shall be taken as 50 mm/hr.
- The drainage system shall be planned to carry storm run-off from the proposed areas shown in the scope drawings.
- No allowance for sullage shall be kept.
- A maximum velocity of 3.0 m per second shall be allowed for RCC channel with lined surface.
- Manning coefficient for pipe material shall be adopted as follows:
 - Concrete surface in good condition - 0.015

The design of the structural components shall be carried out either using Staad Pro or manually using standardized excel spreadsheets for the loads and their combinations. All designs of RCC structures shall be carried out by limit state method as per IS :456 cracked section.

7B.3.14 Compressed Air Supply

Compressed air is used for various applications on modern surface warships. The compressed air requirement at North Jetty is 7 bar for LP. The space requirement for installation of air compressors would be 10m x 6m x 6m which will be located on reclaimed land. Compressed air systems would be laid as Main pipe with 80mm Dia galvanized steel tube, which is proposed to run from compression room to main jetty through the utility corridor and distributed with 60 mm galvanized steel tube. Compressed air tapings are kept at 75m interval on both sides of Main Jetty. To regulate compressed air flow, ball valves of 80mm are provided in main pipe line and Distribution pipeline respectively.

7B.3.15 Oxy-Acetylene System

The Contractor shall provide separate sheds for storage oxygen and acetylene gas and discharge facility, which shall be designed and installed by a specialist company. 20 cylinders of minimum 7 cum capacity of each shall be provided.

Two banks of cylinders for each gas shall be provided of 10 cylinders each, one operation and one standby. The sizing of respective shed shall allow for storage of one set of cylinders for a bank.

The Contractor shall provide a dry pipe sprinkler system within the acetylene storage compound in accordance with NFPA 13. The sprinkler system shall be connected to fire and gas detection system which shall initiate the sprinkler system in the event of a fire within the compound or close by. This fire protection system including equipment, pipework, valves, controls etc shall be designed to meet the safety requirements. All electrical equipment and wiring within in the storage sheds shall be with flame proof fittings.

7B.3.16 Electrical Distribution System

7B.3.16.1 General Design Philosophy

The design shall provide the expected performance and be suitable for the purpose in accordance with the requirements. Earthing, lightning and protective devices to be designed for safe and efficient operation of the Electrical distribution system. Safety clearances to be provided as per the statutory requirement for free movement of operation and maintenance personnel. The design shall be suitable for the local environmental conditions of the site and shall incorporate energy efficiencies and installation practices which minimize damage to the environment.

7B.3.16.2 Design Standards

The works and equipment shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India. The design concept and design guidelines shall comply with the following local and relevant standards and requirements.

- Indian Electricity Act
- CEA Regulation
- National Building Code
- Indian Standards
- Kerala State Inspectorate regulations
- Local Municipal Authorities
- Current Local Authority Regulations

Whenever necessary the list of standards shall be considered in conjunction with specific IEC / IEEE. City, State and Country rules and Safety Standards shall take precedence over these specifications in case of conflict. In case of conflict between Codes, Standards and this Technical Specification, the most stringent requirements shall apply, unless otherwise approved by the Purchaser.

7B.3.16.3 Design Life & site conditions

The electrical system shall be designed to operate 24 hours/day, 365 days/year. The minimum economic life of the equipment shall be 30 years. Site data given in the section 2 shall be used while designing the Electrical power distribution system. Electrical equipment and material to be selected to withstand the corrosive atmosphere.

7B.3.16.4 Degree of Protection

The following degree of protection classes shall be applicable if the IP class is not specifically mentioned in the respective specification.

Installed outdoor	: IP65
Installed indoor in Air-conditioned area	: IP43
Installed in covered area	: IP54
Installed Indoor in non-A/C area where possibility of entry of water is limited	: IP41
LT Switchgears (AC&DC Distribution Boards)	: IP54

7B.3.16.5 Source of Power Supply

The power supply for the proposed “North jetty project” will be tapped from the 110KV MES substation.

7B.3.16.6 Maximum Demand calculation

Electrical distribution system for the “Re-Construction of North Jetty at Naval Base, Kochi” project is designed to feed power supply to the vessels listed in the table below, High mast lighting, outdoor lighting, Rail Mounted Tower Cranes, EOT Cranes, Service Gallery, Firefighting system, Water supply system, Compressed air system, gates & following buildings etc.

- Power House
- Office Cum Store Building including Pump House (G+2)
- DG Room

- Compressor House
- Guard Room
- Watch Towers – 2 Nos.
- Entry Gate

7B.3.16.6.1 Load details of Naval Vessels

S. No.	Ship	Load Requirement (KVA)	Voltage / Frequency /Phase
1	Vikrant (IAC)	5610	--
2	Viraat	1900	440 V/60 Hz/ 3Ph
3	Deepak	1100	415 V/50 Hz/ 3Ph
4	Gharial	600	415 V/50 Hz/ 3Ph
5	Kesari	600	415 V/50 Hz/ 3Ph
6	'G' Class	800	450 V/60 Hz/ 3Ph
7	Delhi Class	600	380 V/50 Hz/ 3Ph
8	Sagar	400	415 V/50 Hz/ 3Ph
9	Mahish	200	415 V/50 Hz/ 3Ph
10	'R' Class	700	380 V/50 Hz/ 3Ph
11	Betwa	1000	440 V/60 Hz/ 3Ph
12	Teg	550	380 V/50 Hz/ 3Ph
13	Survey class	350	415 V/50 Hz/ 3Ph
14	OPV Class	400	415 V/50 Hz/ 3Ph
15	Cheetah	350	380 V/50 Hz/ 3Ph
16	Sagar Dhawani	300	415 V/50 Hz/ 3Ph

Maximum Demand for the proposed North jetty was worked out based on berthing scenarios explained below.

7B.3.16.6.2 Electrical load during Berthing Scenario – I

- (i) Load on 415, 50 Hz system = 2400 KVA
- (ii) Load on 380, 50 Hz system = 2500 KVA
- (iii) Max. Expected ships/vessel load [(i) + (ii) above] = 4900 KVA

7B.3.16.6.3 Electrical Load during Berthing Scenario - II

- (i) Load on 440, 60 Hz system = 1900 KVA
- (ii) Load on 415, 50 Hz system = 825 KVA
- (iii) Max. Expected ships/vessel load [(i) + (ii) above] = 2725 KVA

7B.3.16.6.4 Electrical Load during Berthing Scenario - III

Max. Expected ships/vessel load as per Scenario-III = 6500 KVA

7B.3.16.6.5 Maximum Demand:

In addition to above, approx. load of all utilities/ services, of North Jetty including 50T cranes, will be 1000 KVA. For planning total load requirement of the reconstruction proposed North Jetty, we will consider Scenario III, which has the maximum expected ship/ vessels load of 6500 KVA. Adding 1000 KVA for utilities / service load, the total maximum expected load for the jetty will be 7500 KVA (6500 KVA +1000 KVA). Leaving safe margin of approx. 20 % for overloading / unforeseen load requirement in future, 9 MVA bulk load connection will be required to be taken from 110KV MES Sub-station for meeting with the power demand for proposed North Jetty. The load capacity shall be calculated and provided by the Contractor as per his design, but capacity of 9 MVA shall be provided as a minimum.

7B.3.16.7 Distribution Voltage and Frequency:

Power supply to the reconstructed North jetty and other installations and auxiliaries will be fed through new substations on different systems as follows:

AC Distribution Voltage	DC Distribution Voltage
110 KV, 3- phase, 50 Hz	220 V, DC
11 KV, 3- phase, 50 Hz	
415 V, 3- phase, 50 Hz	
380 V, 3- phase, 50 Hz	
440 V, 3- phase, 60 Hz	

7B.3.16.8 Proposed power supply arrangement (HT)

Power will be received from new 110KV MES substation, whose location would be nearby foot-over Bridge in SMA (inside naval base). The approximate distance for MES substation is 3.75 km from the project site. 9 MVA installed capacity has been envisaged for new Power House to be constructed on the reclaimed land, for day to day operations of various systems and to meet the peak load demand of about 7500 KVA. Four 11 KV feeders are now proposed to feed installed load capacity of 9 MVA, from the nearly 110 KV MES receiving station, to be connected to new North Jetty Power House, on the 11 KV system. This will include one spare 11KV feeder. These incoming feeders will be connected to 11kV Bus-bar in the new north Jetty substation through of Aluminium cables via cable trench/duct, where 11 KV switch gear panels will be installed for all incoming & outgoing 11 KV feeders.

7B.3.16.9 Proposed power supply arrangement (LT)

Taking into account the load requirement in each system, Transformers, Frequency converts and the LT panel Boards are proposed to be installed in the substation. The L.T output from various Transformer / Frequency convertors will be extended to Pillar boxes, spaced all are on lee side of North jetty and the supply from these pillar boxes will be connected to various cope boxes, fixed in the gallery on lee side / sea side for giving power to various vessels on different systems i.e. 415 V / 50Hz, 380 V / 50Hz & 440V / 60Hz & 220 VDC. Location and details of pillar boxes and cope boxes are shown in drawing **60614746-DWG-TD-0000-PL-4007**. In addition to that the LT Panels feed supply to the Building Loads, External and internal lighting & power loads, Crane loads, Service Gallery loads and other utility services.

7B.3.16.10 Emergency and standby power system

An independent source of electric power shall be available for operation of vital installations. The control room, lighting system, Jetty crane etc. should have standby supply facilities which should be brought into operation in the event of failure of the grid supply from KSEB. The requirements of standby power supply systems will be met through a 2 x 250KVA rating diesel driven generator set.

7B.3.16.11 Details of Equipment Proposed to be installed

Equipment proposed for the project is listed in the below table. However the Contractor shall size the equipment according to the load demand, design criteria & to meet the functional requirement.

S. No.	PARTICULARS	QUANTITY
EQUIPMENT LIST AT 110 KV RECEIVING STATION (MES)		
1	110/11 KV 10/12.5 MVA Transformer	1 No.
2	110 KV Breaker	1 No.
3	110 KV Isolator	1 No.
4	110 KV C.T	3 Nos.
5	110 KV PT/CVT	3 Nos.
6	110 KV LA	1 No.
7	11 KV Panels	5 Nos.
8	11 KV Bus coupler	1 No.
EQUIPMENT LIST AT NORTH JETTY SUB-STATION (Indoor)		
9	11 KV/0.415 KV, 50 Hz, 1600 KVA Transformer, Dry type	6 Nos.
10	11 KV/0.380 KV, 50 Hz, 1000 KVA Transformer, Dry Type	3 Nos.
11	11 KV/0.440 KV, 50 Hz, 1500 KVA Transformer, Dry Type	3 Nos.
12	Emergency Generator D.G Set, 250 KVA	2 No.
13	Rectifier Transformer 415 V/ 220 V 500 KVA	2 Nos.
14	Low Pressure compressors 7.5 Kg/ cm ² (200 psc)	3 Nos.
15	Capacitor Banks, 500 KVAR	3 Nos.
16	Rotary Freq. Convertors (440 V, 60 Hz, 1500 KVA)	3 Nos.
17	O.T Crane for P/ House 15 Ton	1 No.
18	Pillar Boxes	15 Nos.
20	Cope Boxes	36-40 No.

S. No.	PARTICULARS	QUANTITY
21	Outdoor LLC (50 T) for North Jetty	2 Nos.
22	11 KV incoming panel for 3MVA load	4 Nos.
23	11 KV outgoing feeders/ TRF Panels	12 Nos.
25	11 KV Bus coupler	1No.
26	11 KV Spare Switch Gear Panel	2 Nos.
27	L.T Panels for 2300-2500 A Loads	30 No.
28	L.T. Panels for Bus coupler	1 Lot.
29	L.T. Panels for charge over switch (COS)	5 Nos.
30	Rectifier (500 KVA, 220 V D.C)	2 No.
31	Power house control room arrangements with panels for operations/monitoring the complete power supply system	1 lot.

7B.3.16.12 110KV Receiving station (MES)

110KV equipment such as Isolator, Breaker, CT, PT/CVT, Lightning arrester and power transformer will be installed in the outdoor area of the 110KV MES Receiving station. Detailed design calculation, equipment sizing calculation, layout drawing, foundation and structural drawing to be provided. Fault level calculation to be prepared and submitted for approval for the complete electrical distribution system and accordingly the equipment to be sized. Relevant codes and standards, CEA regulations to be followed to design the outdoor switchyard. 11KV Switch board panels will be placed indoor in MES substation. Equipment arrangement and clearances shall be maintained as per NBC. All the switch yard equipment and 11kV substation equipment shall be interfaced to SCADA system

7B.3.16.13 Power transformer (110kV/11kV, 50Hz)

The power transformer shall be designed based on the IS 2026. 20% spare capacity to be considered while sizing the transformer. The Power Transformers shall be Core Type, Oil Immersed (mineral oil) with ONAN/ONAF cooling and suitable for Outdoor installation. The transformers shall be complete with standard accessories and equipped with the following protective devices: -Buchholz relay with double floats, one for alarm and one for trip. Dial type Thermometers with alarm and trip contacts for oil and winding. Magnetic Type Oil Level Gauge with alarm contacts, OLTC, RTCC. The

leads from all the protective devices mentioned above shall be brought out to a weather proof marshalling box mounted on the transformer. Winding material shall be of Copper. Insulation of the winding shall not be less than "A" class. Vector group of the transformer shall be of Dyn11. Temperature rise limit is 45deg C for oil & 50 deg.C for winding over an ambient of 50 deg.C. The power transformer (10/12.5MVA, 110/11kV) secondary side neutral shall be resistance earthed in order to limit the 11kV system earth faults to low values such as to limit excessive damage to 11kV equipment's. The transformer shall be provided with Nitrogen based firefighting system.

7B.3.16.14 North Jetty Substation

North jetty substation is an Indoor substation. Indoor HT Panel Boards, Dry type Transformers, Frequency converters, Rectifiers, Capacitor Bank, Indoor LT Panel Boards, Battery Bank etc. are planned in the Substation Building. The substation layout design and equipment clearance to be done based on the NBC, IS and CEA guidelines. The following design criteria to be considered while sizing the substation.

- All door openings from Substation, Electrical room, etc., should open outwards.
- Rolling shutter is to be provided in the Substation/Electrical room for equipment access.
- For large substation, Electrical room having multiple equipment, 2 or more door shall be provided which shall be remotely located from each other
- Substation/ Electrical room shall have direct access from the outside of the building for operation and maintenance of the equipment
- In case of Two transformers (Dry Type) located next to each other the distance between the two transformer shall be minimum 1500mm for 11kV
- Minimum clearance for Transformer from the wall shall be as per IS:10028- Part 2 & NBC
- The minimum height of Substation/Electrical room shall be arrived at considering 1200mm clearance requirement from top of the equipment/panels to the below of the soffit of the beam.

- The MV panel room shall be provided with fire resistant walls and doors of fire resistance of not less than 120 min
- In order to prevent storm water entering the transformer and switch room through the soak pits, the floor level of Electrical room/Substation shall be at least 300mm above the highest flood water level that may be anticipated in the locality.

7B.3.16.15 11kV Switchboard

Indoor, draw-out, metal clad switchgear will be considered for the proposed North jetty Substation. Circuit breakers will be electrically operated, i.e. electrical closing spring charging, trip release and closing release. Protection and metering will be integral with the switchgear assemblies. Voltage transformers will be bus connected.

The board shall be of IP-4X and outer paint shade shall be RAL-7032 (Siemens grey). Will permit extension on both the sides. Lockout provisions with breakers racked out will be included. Temperature rise of bus bars shall be as per IEC. The protection relays and metering instruments shall be mounted on the front of the hinged door of the control compartment.

Electrical interlocks between the two incomers and the bus coupler will be included such that only one incomer with bus coupler can be switched on and the other incomer will be off. Alternatively both the incomers can be switched on only when the bus coupler is off. Mechanical interlock will also be provided by means of castle key. The switchboard shall have adequate cabling space to terminate 11kv grade Cables. Cable entry shall be from bottom.

Panels made up of special material called "Aluminium Zinc". Aluminium Zinc/ normal CRCA as per Adani painting scheme P-001.

The main bus bar size will be calculated based on the following factors:

- (a) Short Circuit rating
- (b) Continuous Rating of bus bar

The short circuit rating of the bus bar will be calculated based on the following method:

$$A = (I_{sh} \times \sqrt{t}) / K$$

Where,

A = Cross sectional area in Sq.mm.

I_{sh} = Fault current in kA

t = Fault clearing time in seconds

K = Constant kA / sq.mm. (K = 0.0799 for Aluminium)

I_{continuous} = I_{table} X K1 X K2 X K3 X K4 X K5

7B.3.16.16 Feeder Wise Typical Metering & Protection Details for 11kV Switch Board

7B.3.16.16.1 Incomer

Main protection relays such as IDMT Overcurrent Protection (51), IDMT Earth Fault Protection (51N), INST Over Current Protection (50), INST Earth Fault Protection (51N), Under Voltage protection (27), Over Voltage protection (29) to be provided. Auxiliary protection relays such as Breaker Multiplication Relay 52X, DC Failure Relay 30, Master Trip Relay 86, Anti Pumping Relay 94, Trip Circuit supervision 95 to be provided. Metering: 3Ph Ammeter with selector switch, 3Ph Voltmeter with selector switch, Digital multifunctional Meter to be provided. Upstream Breaker interface/inter trip to be considered along with cables.

7B.3.16.16.2 Bus Coupler

Main protection relays such as IDMT Overcurrent Protection (51), IDMT Earth Fault Protection (51N), INST Over Current Protection (50), INST Earth Fault Protection (51N) to be provided. Auxiliary protection relays such as Breaker Multiplication Relay 52X, DC Failure Relay 30, Master Trip Relay 86, Anti Pumping Relay 94, Trip Circuit supervision 95 to be provided. Metering: 3Ph Ammeter with selector switch, 3Ph Voltmeter with selector switch, Digital multifunctional Meter to be provided.

7B.3.16.16.3 Bus PT

Main protection relays such Under Voltage protection (27), Over Voltage protection (59) to be provided. Auxiliary protection relays such as DC Failure Relay 30 to be provided. Metering: 3Ph Voltmeter with selector switch, toe provided.

7B.3.16.16.4 Distribution Transformer Outgoing Feeder

Main protection relays such as IDMT Overcurrent Protection (51), IDMT Earth Fault Protection (51N), INST Over Current Protection (50), INST Earth Fault Protection (51N), 50NS- Stand By earth fault protection to be provided. Auxiliary protection relays such as Breaker Multiplication Relay 52X, DC Failure Relay 30, Master Trip Relay 86, Anti Pumping Relay 94, Trip Circuit supervision 95, 63XA Transformer Buzhlozh Alarm protection, 63XT Transformer Buzhlozh Trip protection, 49WA Transformer Winding Temperature Alarm protection, 49WA Transformer Winding Temperature Trip protection, 49OA Transformer Oil Temperature Alarm protection, 49OA Transformer Oil Temperature Trip protection to be provided. Metering: 3Ph Ammeter with selector switch, 3Ph Voltmeter with selector switch, Digital multifunctional Meter toe provided.

7B.3.16.16.5 Outgoing Power Feeder

Main protection relays such as IDMT Overcurrent Protection (51), IDMT Earth Fault Protection (51N), INST Over Current Protection (50), INST Earth Fault Protection (50N) to be provided. Auxiliary protection relays such as Breaker Multiplication Relay 52X, DC Failure Relay 30, Master Trip Relay 86, Anti Pumping Relay 94, Trip Circuit supervision 95 to be provided. Metering: 3Ph Ammeter with selector switch, 3Ph Voltmeter with selector switch, Digital multifunctional Meter toe provided.

The following are the auxiliary supply and control supply voltage for 11KV Panel Boards

Voltage for spring charging motor mechanism (Power will be derived from MAIN LT PANEL)	230V AC, 50Hz
Control voltage for closing, tripping, indication, interlocking, annunciation circuits etc.	110V DC
Auxiliary power supply for relays, transducers etc.	110V DC
Panel Space Heaters, Cubicle illumination lamp, Plug Socket, Circuits of all panels and motor space heaters etc.	230V AC, 50Hz

Current Transformers

CT shall be sized based on the relevant IS standard. CT's shall be bar/window Primary type. 2core / 3core CTs shall be employed for measuring instruments and automatic tripping of circuit breakers on over load and short circuit protection/differential protection. Separate cores shall be used for Metering, Main and Back up protection. Insulation level of CT shall be same as that of circuit breaker & Short time ratings shall be suitable for duration of 1 sec. Accuracy Class of CT cores shall be as follows. a) Over current & Earth Fault: 5P20, b) Metering : 0.5, c) Spare Core: 0.2S

Potential Transformers

PT shall be sized based on the relevant IS standard. All PT's shall be single phase and Mounted on a carriage for each BUS PT and Line PT. The Accuracy class of PT's shall be as follows. a) Protection: 3P, b) Metering: 0.5. For each Line PT HRC Fuse protection of adequate rating shall be provided on HT side and LT side of appropriate rating shall be used. PT's shall have Insulation level corresponding to the switchgear with which these are associated.

7B.3.16.17 Dry Type Transformer

Transformer is to be comply with IEC 60076 and IS 11171. 20% spare capacity to be considered while sizing the transformer. The dry type transformer shall be of Cast Resin type, 3 Ph., 50 Hz, vector group DYN-11, copper wound transformer with OFF load tapings from +10% to -10% in steps of 2.5% with all the necessary protection etc. to be provided. LV Chamber to be provided in the LT side of the transformer. This chamber shall be suited for termination and connection of aluminium conductor armoured cable/Bus duct as per requirement. A control terminal box shall be provided on the base frame. Forced cooling system to be provided for the transformer according to the requirement.

7B.3.16.18 Low Voltage Power Distribution panel

Main LT panel construction will be indoor duty, free-standing, metal-enclosed, single front and non-draw out type. The board will be designed to meet the fault level for 1 second. Control supply shall be 110V AC from a separate control transformer for each section of Main LT PANEL.

Main LT panel will be connected to the Transformer secondary through suitable rating Bus Duct. If cable is used, suitable adopted boxes to be designed to accommodate the cables. Bus duct is not allowed inside the service gallery.

- From Main LT panel power to be fed to various Distribution boards.
- From lighting distribution boards, power will be provided to each switch board / receptacles.
- From Power distribution boards, power will be provided to each receptacle.
- From UPS distribution boards, power will be provided to each UPS plug points & emergency lighting.

Single point power supply shall be provided to lift panel, Water supply & plumbing panel, HVAC / AHU panel & Fire Hydrant panel and supply, installation, testing and commissioning of respective panels and all further electrical wiring / cabling work.

Generally the following criteria used for LT panel board bus bar sizing:

- Calculation of bus bar and incomer current rating
- Sizing of main bus bars for short circuit and thermal rating
- Voltage drop for bus bars

Pillar Box and Cope Box are outdoor type and they are kept in the Jetty area. The switchgear inside the Pillar box shall be of Marine duty.

7B.3.16.19 Battery & Charger System

7B.3.16.19.1 DC Control Power Supply:

The battery charger float cum boost charger with common battery bank and associated DC distribution board shall be used to provide control supply for the switchgear installed for power distribution system. DC Voltage shall be 110DC.

Battery: The tentative batteries shall be 240Ah VRLA, rated for 110 V DC with 1 hours back up at rated load. However the same to be verified as per load requirement.

Mode of Operation: - The battery charger shall be designed with a switch, which gives a choice of three operating modes: a) Automatic mode b) Float mode c) Charge mode

The charger shall be regulated to a constant voltage on either of 2 settings, floating & charging, with limited current.

General: In this project all the DC loads shall be fed from 110V battery. The calculation for sizing of the battery and its charger are shown below. The battery is to supply the DC power requirements during the following conditions: a) Load on dc system exceeds the maximum output of the battery charger. b) Output of the battery charger is interrupted. c) AC power is lost

The following factors will be considered while designing the battery system:

Temperature de rating factor: The operating temperature affects the available capacity of a cell. The standard temperature for stating cell capacity is 20 deg.C. If the lowest expected electrolyte temperature is below standard a cell large enough to have the required capacity is selected. The capacity deration factor for the same is known as temperature factor. Temperature correction factor shall be 1.14.

7B.3.16.19.2 Design Margin:

As a prudent design we are to provide a capacity margin to allow for unforeseen addition to the DC system. The performance of a lead acid battery is relatively stable throughout most of its life, but begins to decline at the later stage of its life.

7B.3.16.19.3 Design Considerations:

The battery sizing is done for a duty cycle of 60 minutes. The calculated battery size is to be corrected for design margin, aging compensation, and minimum temperature. The batteries considered are sealed, maintenance free lead acid type with a 10 hour discharge rate i.e. C10 batteries. 2 volts batteries with end cell voltage of 1.75V are considered

K factors corresponding to 1.75 end cell voltage and temperature correction factor for the lowest ambient temperature are taken from Exide batteries Ltd

This calculation is done for battery nominal voltage of 110V DC which is the control supply voltage

7B.3.16.19.4 Design Basis:

The loads on the battery are mainly pertaining to HT switchboard control supply only.

It is required to be identified which all loads are instantaneous and which all loads are continuous. For example an 'on' lamp in a breaker feeder is a continuous load, while a tripping relay is an instantaneous load coming in at the time of a trip.

A design margin of 5% may be allowed for unforeseen additions or future expansion as well as for below optimum operating conditions.

Battery capacity is referred to at a nominal temperature of 20 deg. Celsius. (The factors given by Exide are at 20deg C). A temperature correction factor for the lowest temperature (1-Deg C) is considered while determining the AH capacity of the battery.

The voltage at the load terminals shall never be outside +10% and -10% of the nominal voltage.

Load Details: The individual loads supplied by battery during the duty cycle maybe classified as continuous or non-continuous. Non-continuous loads lasting for 1 minute or less are designated as momentary loads.

The loads, which are energized throughout the duty cycle, are known as continuous loads. These loads are normally carried by the battery charger and are initiated at the inception of the duty cycle.

Some of the continuous loads are: Indication lamps, (ON, TCH etc.), continuously energized coils, annunciator loads etc.

Momentary loads are non-continuous loads which can occur one or more times during the duty cycle but are of short duration i.e. less than 1 minute. Although the momentary loads may exist for only a fraction of second, it is common practice to consider that each load will last for one full minute because the battery voltage drop after several seconds.

Some of the typical momentary loads are: switchgear coil operations (trip and close), etc.

The AH capacity of the battery is calculated as:

$$AH = AH1 * K1 * K2 * K3$$

Where K1 = Ageing Factor

K2 = Design Margin

K3 = Temperature correction factor (For the lowest temperature of 10deg C)

7B.3.16.19.5 Float Charger Capacity

ICC = Continuous DC load current which is the total continuous current requirement calculated for the loads

A design margin of 5 % is considered for unforeseen continues loads.

A trickle charging current ITC is as recommended by the manufacturer. (Usually 2%)

$$ITC = ICC * 0.02$$

The total required capacity of the float charger shall be = $ICC * 1.05 + ITC$

Based on the above calculations float charger capacity will be selected.

7B.3.16.19.6 Boost Charge capacity:

The boost charger shall be equal to maximum allowable battery charging current (generally 14% of the battery amperage or the float charger capacity, whichever is higher).

7B.3.16.20 Cable Sizing Design Basis

7B.3.16.20.1 Power Cable:

Power cables shall be sized to satisfy the following Criteria:

- Short circuit withstand capacity for applicable fault current and duration.
- Full load current carrying capacity under installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
- Permissible voltage drop limits under steady state/transient state as applicable.

Armoured XLPE grade insulated Copper conductor cables are proposed for 11KV HT cables. Armoured XLPE grade insulated Aluminium conductor cables are proposed for LT power distribution. LT Cables of 10 sq.mm & below size will be XLPE/PVC insulated, PVC sheathed, steel braided/ wire armoured copper cables. Care will be taken in design of distribution system to achieve voltage drop of not exceeding 3% to the farthest cable termination.

11kV Power cable from MES substation to north jetty substation shall be of Aluminium. Cables which are running inside the Power House and reclamation area shall be of Aluminium/copper according to cable size. Cables running to Jetty area from power house shall be of Copper.

7B.3.16.20.2 Control Cable:

1.5 Sq.mm (7/0.53 mm)/2.5 sq.mm stranded annealed bare copper conductor. PVC insulated cores laid up and outer PVC sheathed cable armoured as per IEC-502.

7B.3.16.20.3 Instrument Cable:

Stranded annealed bare copper conductor. PVC insulated cores laid up, twisted to form a pair, Mylar taped, aluminium Mylar screened along with drain wire of 7/0.3 mm ATC, Mylar taped and outer PVC sheathed armoured cables.

7B.3.16.21 Internal Electrification (Point Wiring)

For internal wiring, the wires used shall be of following features:

- PVC insulated bright annealed electrolytic grade (99.9% pure) copper stranded for uniformity of resistance, dimension and flexibility.
- Fire Retardant Low Smoke (FRLS), suitable up to 660V grade wires for single phase circuits and 1100V grade for 3 phase circuits as per IS 694/1990 amended up to date.
- Colour coded as below: Phase (R): Red, Phase (Y): Yellow, Phase (B): Blue, Neutral: Black, Earth: Green

Wire sizes of Copper conductor are as follows.

- Light point / Sub main wiring : 1 / 1.5 sq.mm
- Light Circuit Point : 2.5 sq.mm
- AC points 4/6.0 sq. mm as per requirements

MCB distribution boards with RCCB+MCB's / RCBO's are proposed for light and power distribution. Every area will have localized switching and distribution board controlled lighting shall be considered for common and external areas. Power outlets will be provided throughout the floor. Data points/Computer points to be provided as per requirement of the Employer to be mentioned during construction stage.

7B.3.16.22 Wharf & Berth area Lighting

Wharf lighting is needed for security, safety, and operations. For lighting purpose, 30m high mast lighting consisting of 12 number LED lights is proposed to be provided on the jetty at an interval of 100 m. On the reclaimed land, the same has been provided at the longitudinal interval of 100 m and transverse interval of 50 m for efficient functioning during night. Electric poles are proposed at 10 m interval in the berth area & for road lighting. Underdeck lighting and Kerb lighting to be provided in the Jetty.

7B.3.16.23 Building Lighting & External Area Lighting

The recommended values of illumination level for various areas are indicated in the Table below. Lighting design to be done to match the average lux level. Provision for lighting in external areas like parking, building facades, walkways, entries, exits, canopies, building grounds can also be considered. In order to supply interior with natural light where there is no opportunity to install roof or vertical windows, Tunnel lighting can be used as an effective solution.

S. No.	Description	LUX Level	Type of Luminaries
1	Conference / Office / Training Room	500 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness SMD LED
2	UPS / Electrical Subststion	300 Lux	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink
3	Corridor	200 Lux	LED recess mounted fixture

S. No.	Description	LUX Level	Type of Luminaries
4	Control Room	500 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness SMD LED
5	Server Room	300 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness SMD LED
6	Kitchen & Dining area	300 Lux	Indoor surface mounted LED Linear fitting
7	Toilet	200 Lux	Indoor surface mounted LED Linear fitting
8	Lift Lobby and stairways	200 Lux	LED recess mounted fixture
9	Locker room	100 Lux	LED Panel with ultra-modern recess mounting luminaire suitable for Armstrong/grid/POP ceiling complete with separate electronic driver & high brightness SMD LED
10	Workshop	150-300 Lux	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink

S. No.	Description	LUX Level	Type of Luminaries
11	Utility Building/ Pump House	200 lux	General Purpose Industrial compact batten LED Tube Light fitted with Aluminium heat sink
12	Access Walkway/Service Gallery/Tunnel	50 lux	Well Glass LED Light Fittings/ Flame proof LED light Fittings
13	Open landscape area/Near Main Berthing area/ Road Lighting	30 lux	Outdoor LED light fittings

7B.3.16.24 Emergency lighting system

On failure of normal A.C. supply, emergency A.C. lighting will be provided in selected areas for general visibility, safe movements and operation of important auxiliaries. The power for A.C. emergency lighting will come from UPS backup. The power supply for emergency lighting shall be 230V, 3ph, 3W, 50HZ, none effectively grounded. The emergency lighting load shall comprise at least 10% of the normal lighting load. The system shall be provided for certain strategic locations, Panel Rooms, Control Rooms, Office area and staircases. The lighting fixtures connected to this system shall be normally "ON" during the normal AC system. These will be fed from UPS 1-phase, 2-wire supply distribution boards due to failure of normal power supply.

7B.3.16.25 Capacitor compensation with APFC

Capacitor of required size shall be designed for reactive power compensation connection location to be designed as per operational/load requirement. Adding proper size of Capacitor will result in compliance to statutory norms, reduced energy bill, reduced energy loss in cables, increased system capacity, etc.

Capacitors, for power factor correction, to be considered are of the low-loss, metal-enclosed, hermetically-sealed type. Capacitors should be of the self-healing type. Individual capacitors shall be controlled by contactors, and circuit breakers. Switching Device shall be of required Capacitor Switching Duty, rated for at least $1.5 \times I_n$, and

are able to withstand transient inrush currents up to $100 \times I_n$ (Where I_n is nominal current of connected capacitor banks). The capacitor is turns ON with a fixed time delay to ensure that capacitor is disconnected from the system during the starting of DG by introducing a timer. Harmonics can reduce the life of Capacitor. Therefore, proper Harmonic filters to be considered with Capacitor.

7B.3.16.26 Uninterrupted Power Supply System (UPS)

100% UPS back up should be provided for all low voltage services like Computer, EPABX, emergency lighting, fire detection panel, CCTV cameras, Access control system, public address system, Entry – Exit signage etc. The UPS used will be microprocessor based online type with IGBT and automatic static bypass switch. The UPS will be provided with SMF batteries with required size of battery backup. The loads on the UPS can generate 3rd, 5th and 7th harmonic distortion. The UPS shall be so designed that these harmonics are not reflected at the output and that total harmonic distortion shall not exceed 5% at any load condition measured at the output of the UPS. UPS backup power supply to be provided for the aviation light in the High mast, Cranes, Water tank etc.

7B.3.16.27 Diesel Generator (DG Set)

Outdoor Diesel generators of minimum 2 x 250KVA shall be provided as backup for the electric loads within the premises. The DG set shall be provided with integral Acoustic enclosure & AMF cum synchronizing cum load sharing panel.

The DG set shall conform to the latest revision of relevant Indian or British Standard (BSS) as indicated below and Codes together with the requirements of the Local Supply Authority. Engine shall conform to BS 5514/IS: 10000 and the alternator shall be in accordance with IS: 4722/BS: 2613/IEC-34(Part-1).

The engines shall have 10% overload capacity for one hour in every 12 hours of operation. The Generator shall have permissible over load of 10% for one hour in every 12 hours of operation. The following design criteria to be considered while sizing the DG room.

- D.G sets should not be allowed to be installed above ground floor or below the first basement level of the building. In case of DG set located in Basement, the ceiling of the D.G room shall be the Ground floor slab
- The height of diesel generating (DG) set rooms shall however be not more than 3000 mm above the DG set height, unless required due to DG room ventilation requirements.
- The DG set room shall be separated by 120 min (2 Hour) fire resistance rated walls and doors.
- Minimum 1.5 meter free space is a must for 100 KVA and bigger DG Set, for smaller DG Set it should be 1 meter
- In order to prevent storm water entering the DG room and switch room through the soak pits, the floor level of Electrical room/Substation shall be at least 300mm above the highest flood water level that may be anticipated in the locality.

DG set shall feed supply to the Lighting system in the Building & outdoor, Crane, ELV equipment etc. during primary source failure.

7B.3.16.28 PLC & SCADA system, Building/Energy Management System

Power consumption system/ Energy management system which is required for acquisition of power generation/consumption data shall consist of one number of microprocessor-based PLC complete with suitable to interface with DG set, measuring and protection devices in the Electrical panel Boards. Equipment such as MFM meters, protection devices and shall be provided with RS485 communication facility. Panel Boards shall be provided with PLC interface relays for remote operation and monitoring.

SCADA system to be provided in both MES substation as well as in the north jetty substation and both systems to be interfaced. PLC/SCADA system architectural drawing to be prepared and submitted for Employer approval.

7B.3.16.29 Cable Trays and Supports

All cable trays and accessories shall be made of the GI Material, pre-fabricated in the factory. It shall comply with the specifications of National Electrical Code (NEC), National Electrical Manufacturer's Association (NEMA), IS 226 and IS 2629. Each cable tray shall be continuously earthed using GI strips. 20% spare space to be considered while sizing the cable trays.

The ladder type trays shall have side rails and horizontal rungs. Both of these shall be of same material. The rung shall be placed 300 mm apart from each other. Hardware of the fastener must be SS-316 with double plain washer.

The cable trays shall be supplied in standard lengths of 3000mm and clear width of trays shall be 150, 300, 600 mm. The tolerance on width and length shall be limited to +/- 6 mm. The overall width of the cable tray shall not exceed inside width by more than 100mm. The inside depth of cable trays shall be 100mm.

Tray layouts: Cable tray layout shall be prepared in line with the equipment/civil layout, Size of the cable tray will be selected based on no. of cables loading in the particular area. And cable tray will be segregated as different types with reference to voltage levels and cable tray will be arranged in the following sequence as mentioned below.

- Instrumentation Tray (24VDC/4-20mA) - Top Row
- Control Tray (230VAC/110VDC) - Top below Row
- LT Power Tray (440VAC) - Bottom above Row
- HT Power Tray (11kV) - Bottom Row
- Cable trays to be considered in the service gallery, MES substation to north jetty substation cable trench, Cable trench inside buildings & switch yard and other area as per design requirement.

7B.3.16.30 Earthing system

All earthing practices shall be as per Indian Standards (IS 3043: 1987), IEEE: 80-2000 Guidelines, and CEA safety regulation. All non-current carrying metal parts of equipment shall be double earthed using conductors of adequate size. Transformer and generator neutral shall be double earthed. One independent earth electrode shall be provided for neutral earthing. Links shall also be provided in neutral earthing conductor. Generator neutral shall be earthed at control panel.

Cu flats/strips are proposed for earthing Transformers, DG set, GI flat/strips are proposed for earthing HT / LT panel boards, etc. and copper wires are proposed for small equipment and MCB DB earthing.

Detailed Fault level calculation, earthing and lightning design calculation to be submitted for approval.

Grounding system will be common for System Grounding and Lightning Protection Grounding and will have following features:

- Grounding resistance of common grounding system will be less than 1 Ω . If resistance value is more than 1 Ω , chemical treatment of soil will be carried to reduce the resistances.
- The grounding conductor will be adequately sized to withstand the maximum ground fault current.
- The earth electrode material used for grounding will be GI. The earthing stations on land side will consist of GI electrodes Interconnected with GI strip conductor.
- Running earth strip will be provided for cable trays used for cable laying.
- This earth strip will be connected to grid & this strip will be earthed at regular intervals.
- Air termination will be directly earthed to dedicated earth pit. This earth pit will be further connected to earthing grid.

- Earthing will be provided to all the metallic structures which are used for electrical equipment mounting.
- The GI earthing strip used for grid will be of full length. Earthing strips will have minimum number of joints & bend.
- All electrical equipment, panels, lighting, motors etc. will be connected to this grid by two separate GI earthing strips / wires.
- The earthing of HV / LV Switchgear, transformers, DG Set, Lighting High Masts, Substation equipment will be ensured by providing earth conductor to the common Earth bus bar at Substation.
- Dedicated Earthing to be provided for UPS, computer and other sensitive electronic equipment / systems.
- Crane rail earthing/Jetty earthing system shall be designed as per the IS 3043 & IEEE 80

7B.3.16.30.1 The Sizes of GI earth bus and earth wires

Sizes of GI/Coper earth wires/strips are given in the below table.

Equipment	Earth Strip/Wire Size
Main earthing grid	75 x 8 mm GI strip
Riser upto ground level/Rail earthing	75 x 8 mm GI Strip
HT & LT switchboards, PCC/MCC panels, Cable trays (HT & LT)	40 x 6 mm GI strip
High Masts Earthing	40 x 6 mm GI strip
LT Motors > 3.7kW and upto 30kW	25 x 6 mm GI strip
Transformers and DG Neutral Earthing	50 x 6 mm Cu Strip
LDB, Weld socket, Cable tray (Control & Instrumentation)	25 x 6 mm GI strip
Lighting panels, DistributionBoards etc	25 x 6 mm GI strip
LT Motors below 3.7kW	12/8 SWG GI Wire

Equipment	Earth Strip/Wire Size
Junction boxes, field instruments, gland earthing Lighting fixtures, 15A switch sockets	12/8 SWG GI Wire
Substation Equipment	
Transformer Neutral Earthing	Copper (600x 600 x 3 mm) Plate
Transformer Body Earthing	G.I. (600 x 600 x 6mm) Plate
H.T. Switch Gear Earthing	Copper (600 x 600 x 3 mm) Plate
D. G. Set Neutral Earthing	Copper (600 x 600 x 3 mm) Plate
D.G. Set Body Earthing	G.I. (600 x 600 x 6 mm) Plate
Panel Earthing	
L.T. Panels Earthing	G.I. Plate Earthing
Distribution Boards Earthing	PVC Insulated Copper wire
Equipment Earthing	Copper Plate
Lighting / Power Point Circuits	1.5/2/4.0/6.0 Sq.mm PVC Wire
UPS/ Server/EPABX Earthing	Copper Plate

7B.3.16.31 Lightning protection system

Lightning protection system to be designed as per IEC 62305 for the proposed project. . Test link will be provided 1000 mm above the GFL. Lightning arrester shall be mounted above 3 meter from the highest point of the utility block. Grounding resistance of common grounding system shall be less than 10 Ω . GI earth strip will be laid as down conductors from lightning finial to the Common earth bus at suitable location.

Lightning protection system to be provided for Cranes, High masts, Water tank etc.

7B.3.16.32 Solar PV System

On Grid Roof top solar PV system to be installed in the Office Building and Power House Building roofs and the same to be interfaced with power distribution system in suitable voltage level to feed the loads during day time. The cable used in the Solar PV system shall be of UV resistant. The structural design to be done based on the wind/weather condition of the site.

7B.3.16.33 Approved make of Equipment

The Contractor shall use only the approved make items furnished in the specification. However, if any equivalent make which Contractor tends to supply differs from the approved make, the same has to be submitted to consultant/client for approval.

Note: For any data not specifically given above, relevant codal provisions shall be used for design.

7B.3.17 Cranes

Two rail mounted Tower cranes of cranes of 50 T capacity at minimum 10 m radius and 10T at 50 m radius shall be provided. These cranes shall be electric powered type. The duty requirements, capacities, overall dimensions and functional parameters shall be as described in the specifications.

7B.3.18 Boundary Wall

The boundary wall shall be constructed along the reclamation area towards the land boundary of reclamation to restrict the entry through gate only. The boundary wall shall be with columns infill with block masonry of 3.7 m high with barbed wire fencing of 0.9 m height.

The barbed wires shall be supported over Y beams made of hot dipped GS conforming to IS 2062. The arm length of Y beams shall be 18 inches and minimum 5 mm thick. The interval between two Y beams shall not exceed 2 m. The barbed wire shall be made of GS with 2.6 mm thickness.

RCC column with suitable foundation (either strip footing or piled foundation) shall be provided at a distance of not more than 3 m along the running wall. Columns shall be designed for factored moments and shear during collision of vehicle. Stability of the column and footing shall be checked for Sliding and Overturning considering necessary safety factors.

7B.3.19 Entry gate

The gate should be made of heavy duty galvanised steel members. The height of the gate shall be minimum 3 m as shown on the tender drawing.

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SECTION 7C
DRAWINGS

S.NO.	DRAWING NUMBER	DRAWING TITLE
		GENERAL DRAWINGS
1	60614746-DWG-TD-0000-GN-0001	DRAWING LIST
2	60614746-DWG-TD-0000-GN-1001	OVERALL LAYOUT
3	60614746-DWG-TD-0000-GN-1002	LOCATION PLAN OF EXISTING BOREHOLES
		DREDGING AND RECLAMATION DRAWINGS
4	60614746-DWG-TD-0000-PL-1001	DETAILED LAYOUT OF NEW NORTH JETTY
5	60614746-DWG-TD-0000-PL-1002	DREDGING LAYOUT AT NORTH JETTY
6	60614746-DWG-TD-0000-PL-1003	CROSS SECTION OF DREDGING AREA
7	60614746-DWG-TD-0000-PL-1004	DETAILED LAYOUT OF THE NORTH JETTY COMPONENTS
8	60614746-DWG-TD-0000-PL-1005	DETAILS OF SHEET PILE WALL AND GROUND IMPROVEMENTS
		CIVIL AND STRUCTURE DRAWINGS
9	60614746-DWG-TD-0000-CS-2000	SUPERIMPOSED DRAWING OF PROPOSED JETTY OVER EXISTING NORTH JETTY
10	60614746-DWG-TD-0000-CS-2001	OVERALL PLAN OF MAIN JETTY
11	60614746-DWG-TD-0000-CS-2002	MAIN JETTY - PLAN AND CROSS SECTION
12	60614746-DWG-TD-0000-CS-2003	MAIN JETTY - PILE DETAILS
13	60614746-DWG-TD-0000-CS-2004	MAIN JETTY - LAYOUT OF PRECAST SLAB AND REINFORCEMENT DETAILS (SHEET 1)
14	60614746-DWG-TD-0000-CS-2004	MAIN JETTY - LAYOUT OF PRECAST SLAB AND REINFORCEMENT DETAILS (SHEET 2)
15	60614746-DWG-TD-0000-CS-2005	FIG BAY - PLAN AND CROSS SECTION
16	60614746-DWG-TD-0000-CS-2006	FIG BAY - CROSS BEAMS
17	60614746-DWG-TD-0000-CS-2007	FIG BAY - LONGITUDINAL BEAMS
18	60614746-DWG-TD-0000-CS-2008	FIG BAY - PILE DETAILS
19	60614746-DWG-TD-0000-CS-2009	APPROACH TRESTLE - PLAN AND CROSS SECTION
20	60614746-DWG-TD-0000-CS-2010	APPROACH TRESTLE - DETAILS OF LONGITUDINAL BEAMS
21	60614746-DWG-TD-0000-CS-2011	APPROACH TRESTLE - DETAILS OF CROSS BEAMS
22	60614746-DWG-TD-0000-CS-2012	APPROACH TRESTLE - PILE DETAILS
23	60614746-DWG-TD-0000-CS-2013	TYPICAL DETAILS OF FENDER
24	60614746-DWG-TD-0000-CS-2014	TYPICAL DETAILS OF LADDER AND BOLLARD
		DRAWINGS OF ONSHORE FACILITIES
25	60614746-DWG-TD-0000-PL-3001	DETAILED LAYOUT OF ONSHORE FACILITIES
26	60614746-DWG-TD-0000-PL-3002	POWER HOUSE - GROUND FLOOR DETAILS
27	60614746-DWG-TD-0000-PL-3002	POWER HOUSE - MEZANINE FLOOR DETAILS
28	60614746-DWG-TD-0000-PL-3003	OFFICE CUM STORE BUILDING G+2 (18X15)
29	60614746-DWG-TD-0000-PL-3004	OFFICE CUM STORE BUILDING - PILE LAYOUT
30	60614746-DWG-TD-0000-PL-3005	OFFICE CUM STORE BUILDING PILECAP DETAILS
31	60614746-DWG-TD-0000-PL-3006	DG SET ROOM (15X15)
32	60614746-DWG-TD-0000-PL-3007	COMPRESSOR HOUSE (6X10)
33	60614746-DWG-TD-0000-PL-3008	ELEVATED WATER TANK
34	60614746-DWG-TD-0000-PL-3009	UNDERGROUND WATER SUMP
35	60614746-DWG-TD-0000-PL-3010	DETAILS OF GUARD ROOM
36	60614746-DWG-TD-0000-PL-3011	DETAILS OF ENTRY GATE
37	60614746-DWG-TD-0000-PL-3012	COMPOUND WALL
38	60614746-DWG-TD-0000-PL-3013	HIGH MAST DETAILS
39	60614746-DWG-TD-0000-PL-3014	CROSS SECTION OF ROADS
40	60614746-DWG-TD-0000-PL-3015	LAYOUT OF VENTILATION SYSTEM
41	60614746-DWG-TD-0000-PL-3016	SEWAGE TREATMENT PLANT - LAYOUT PLAN AND DETAILS
42	60614746-DWG-TD-0000-PL-3017	GENERAL ARRANGEMENT OF PUMP HOUSE AT JETTY
43	60614746-DWG-TD-0000-PL-3018	DETAILS OF WATCH TOWER
		SERVICES
44	60614746-DWG-TD-0000-PL-4001	OXYGEN ACETYLENE PROPOSED SYSTEM
45	60614746-DWG-TD-0000-PL-4002	COMPRESSED AIR SYSTEM
46	60614746-DWG-TD-0000-PL-4003	HYDRANTS OXYGEN ACETYLENE AND COMPRESSED AIR TAPPING DETAILS (SHEET 1)
47	60614746-DWG-TD-0000-PL-4003	HYDRANTS OXYGEN ACETYLENE AND COMPRESSED AIR TAPPING DETAILS (SHEET 2)
48	60614746-DWG-TD-0000-PL-4004	FIRE HYDRANT DETAILS
49	60614746-DWG-TD-0000-PL-4005	POWER SUPPLY AT NORTH JETTY
50	60614746-DWG-TD-0000-PL-4006	SUBSTATION LAYOUT
51	60614746-DWG-TD-0000-PL-4007	LOCATION OF PILLAR BOXES AND COPE BOXES
52	60614746-DWG-TD-0000-PL-4008	110 KV MES RECEIVING STATION - LINE DIAGRAM
53	60614746-DWG-TD-0000-PL-4009	PROPOSED POWER SUPPLY DIAGRAM FOR NORTH JETTY
54	60614746-DWG-TD-0000-PL-4010	WATER SUPPLY SYSTEM
55	60614746-DWG-TD-0000-PL-4011	LAYOUT OF HIGH MAST, CCTV CAMERA AND STREET LIGHTING
56	60614746-DWG-TD-0000-PL-4012	STORM WATER DRAINAGE
57	60614746-DWG-TD-0000-PL-4013	GENERAL ARRANGEMENT OF RAIL MOUNTED CRANE
58	60614746-DWG-TD-0000-PL-4014	SITE PLAN FOR MES TO NORTH JETTY S/S CABLE ROUTE

ISSUED FOR TENDER

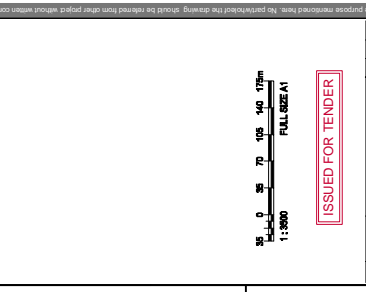
REV	DATE	REVISIONS	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE:					
PURPOSE:					
DRAWING TITLE:					
DRAWING NUMBER: 60614746-DWG-TD-0000-GN-0001					
REV: 0					

DRAWING LIST



NOTES:
 1 ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN METRES.
 3 ALL COORDINATES ARE GIVEN IN METRES RELATING TO UTM PROJECTION, SPHEROID WGS 84

LEGEND:		SIZE (M/m)
S/NO	DESCRIPTION	
1	POWER HOUSE	60 X 25
2	SERVICE BUILDING (G-2)	15 X 15
3	DG ROOM	15 X 15
4	UNDERGROUND WATER PUMP	21.3 X 12.3
5	COMPRESSOR HOUSE	10 X 6
6	ROAD	7m WIDE
7	AREA FOR FUTURE DEVELOPMENT	12m DIA
8	ELEVATED WATER STORAGE TANK	
9	STP	
10	BUILDING FOR OXYGEN CYLINDERS	10 X 6
11	BUILDING FOR ACETYLENE CYLINDERS	10 X 6
12	WATCH TOWER	
13	GUARD ROOM	

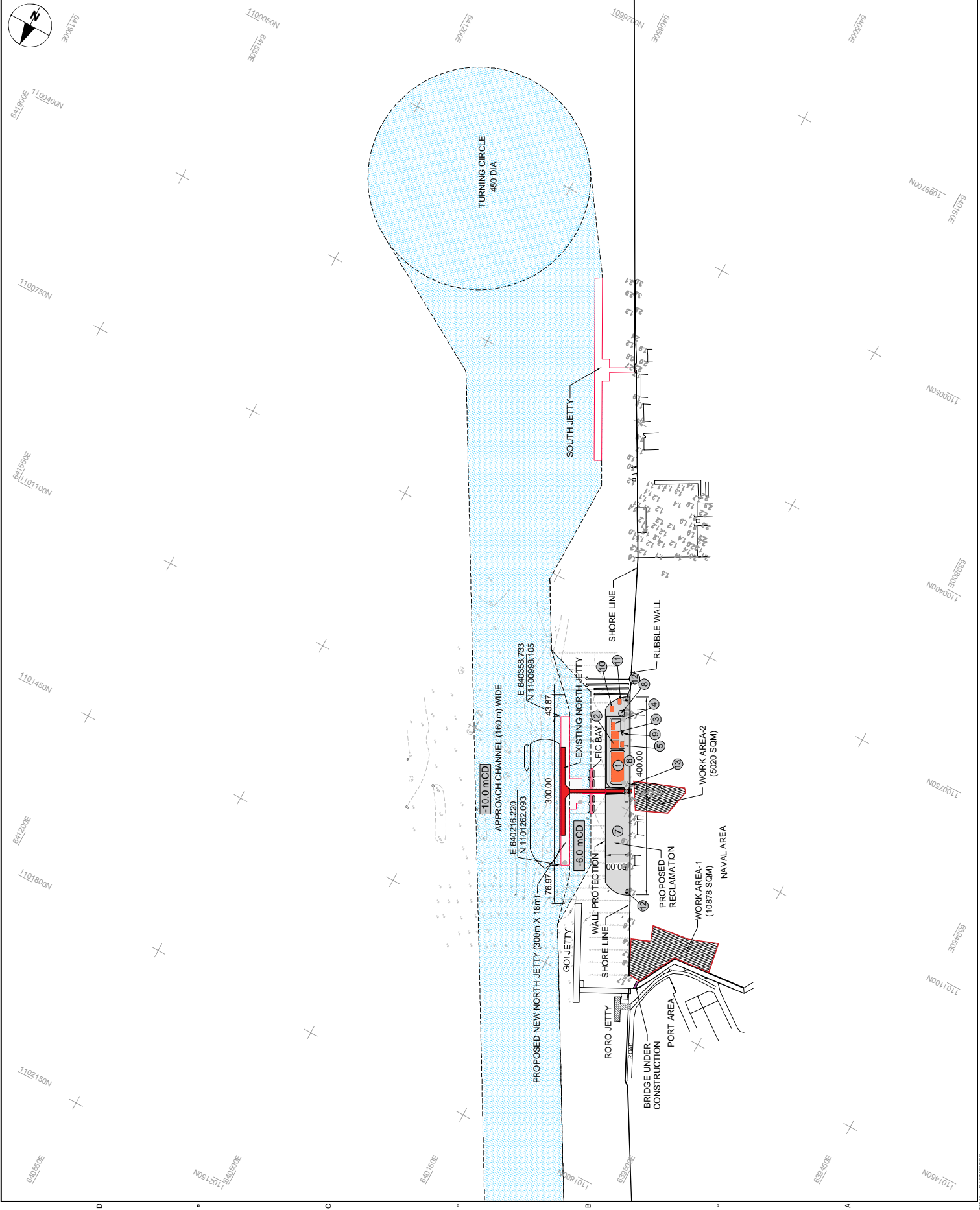


ISSUED FOR TENDER

REV	DATE	DESCRIPTION	DRN	CHK	APP

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPANTS ARE:
 DRAWING NUMBER: 80814746-DWG-TD-0000-GN-1001
 REV: 0
 SHEET 01 OF 01
 DRAWING TITLE: OVERALL LAYOUT

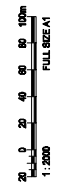
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NOTES:
 1 ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN METRES.
 3 ALL COORDINATES ARE GIVEN IN METRES RELATING TO UTM PROJECTION, SPHEROID/WGS 84

LEGEND:

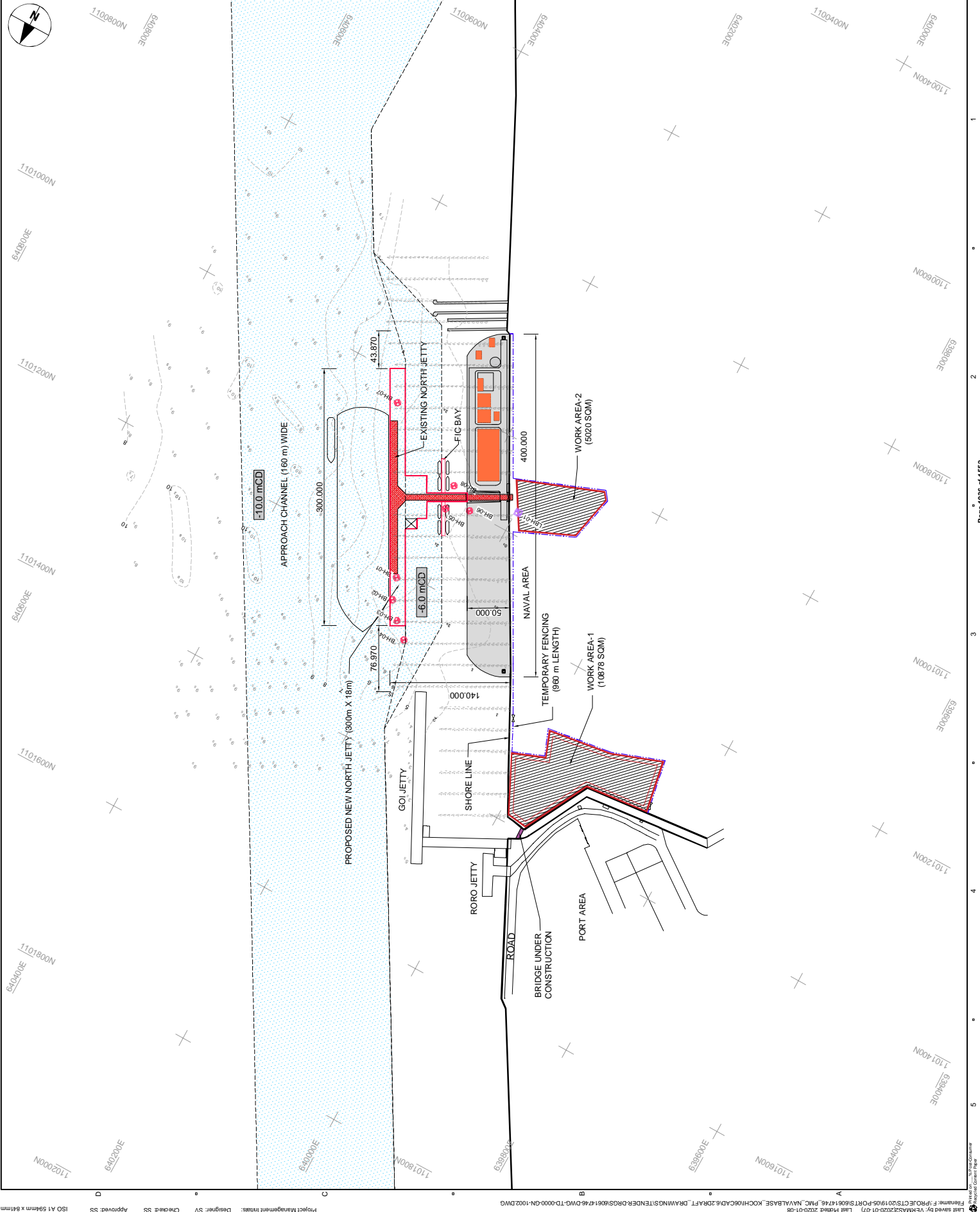
- MARINE BOREHOLE
- LAND BOREHOLE
- TEMPORARY FENCING



ISSUED FOR TENDER

REV	DATE	DESCRIPTION	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICIPATION: DIVISIONS ARE N					
PURPOSE:					
DRAWING NUMBER: 80614746-DWG-TD-0000-GN-1002					
SHEET 01 OF 01					
DRAWINGS TITLE: BATHYMETRIC SURVEY AND LOCATION PLAN OF BOREHOLES					
REV:	0				

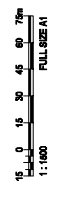
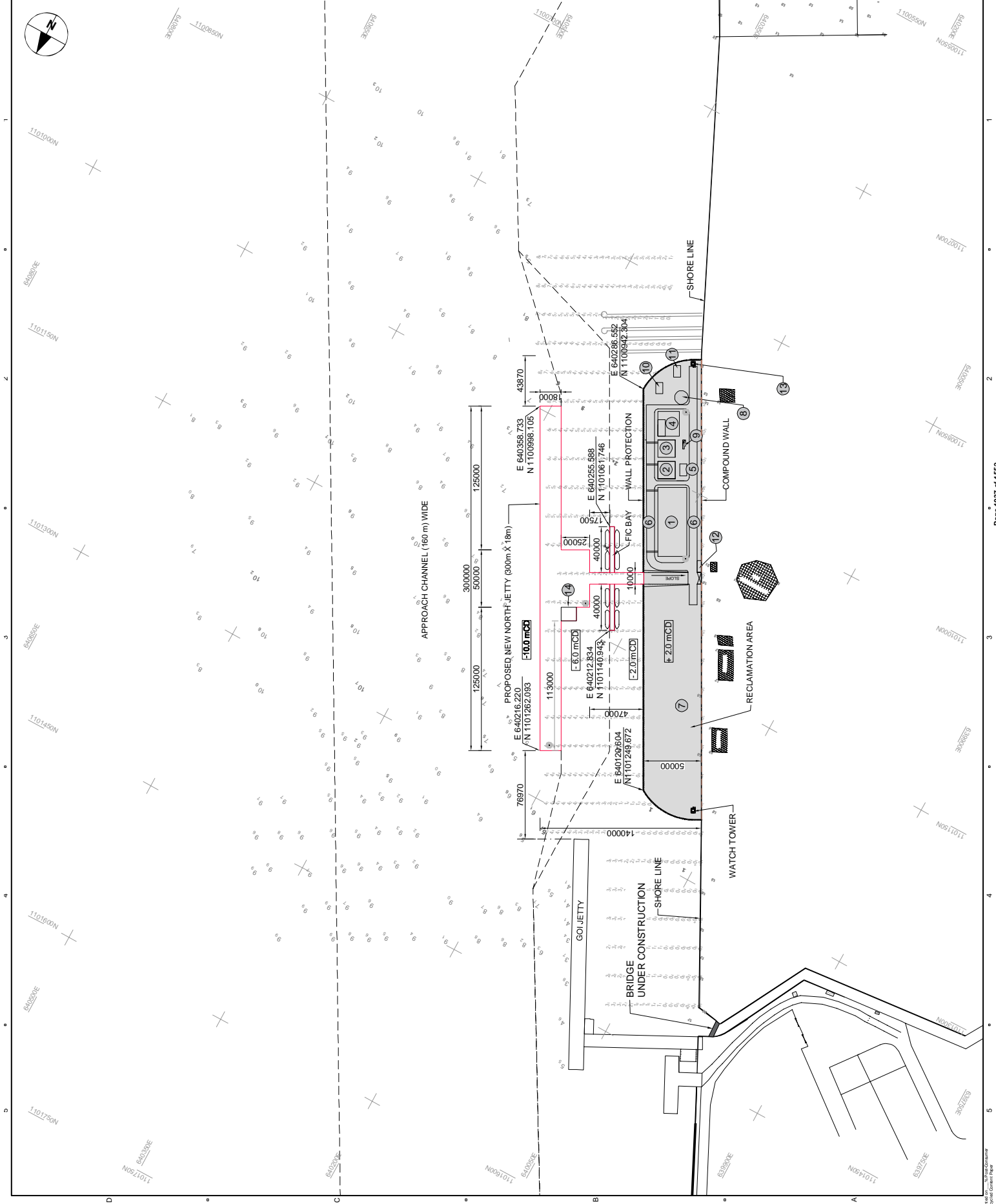
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 AECOM India Pvt. Ltd.



NOTES:
 1 ALL LEVELS ARE IN METERS AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN MILLIMETER, UNLESS SPECIFIED
 3 ALL COORDINATES ARE GIVEN IN METERS RELATING TO UTM PROJECTION, SPHEROID/WGS 84

LEGEND:

S/NO	DESCRIPTION	SIZE (IN M)
1	POWER HOUSE	60 X 25
2	SERVICE BUILDING (G-2)	15 X 15
3	DG ROOM	15 X 15
4	UNDERGROUND WATER	21.3 X 12.3
5	COMPRESSOR HOUSE	10 X 6
6	ROAD	7m WIDE
7	AREA FOR FUTURE DEVELOPMENT	12m DIA
8	ELEVATED WATER STORAGE TANK	10 X 6
9	STP	10 X 6
10	BUILDING FOR OXYGEN CYLINDERS	10 X 6
11	BUILDING FOR ACETYLENE CYLINDERS	3.46 X 10
12	WATCH TOWER	12 X 13.5
13	GUARD ROOM	
14	SEA WATER PUMPHOUSE	



ISSUED FOR TENDER

REV.	DATE	REVISION	BY	CHKD.	APP.
		REVISION DETAILS			
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE IN DIMENSIONS AREA IN					
PURPOSE:					
DRAWING TITLE: DETAILED LAYOUT OF NEW NORTH JETTY AND RECLAIMED AREA					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-1001					
REV.	0				
AECOM India Pvt. Ltd.					

- NOTES:
- 1 ALL LEVELS ARE IN METERS AND ARE WITH RESPECT TO CHART DATUM.
 - 2 ALL DIMENSIONS ARE IN MILLIMETER, UNLESS SPECIFIED
 - 3 ALL COORDINATES ARE GIVEN IN METERS RELATING TO UTM PROJECTION, SPHEROID/WGS 84



ISSUED FOR TENDER

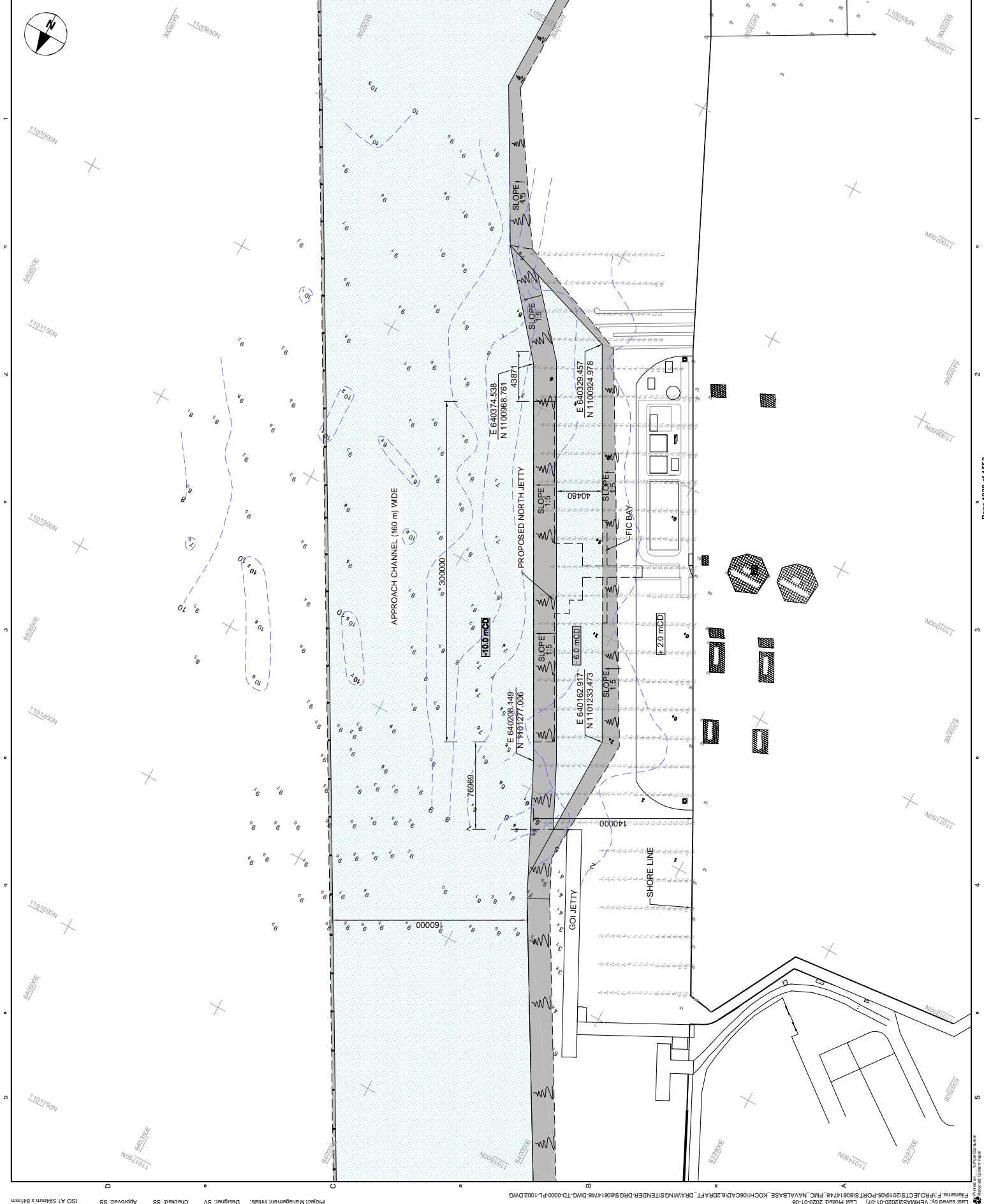
REV.	DATE	REVISION	BY	CHK.	APP.
REVISION DETAILS					

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPANTS: A/E
 PURPOSE: DREDGING LAYOUT AT NORTH JETTY
 DRAWING TITLE: DREDGING LAYOUT AT NORTH JETTY

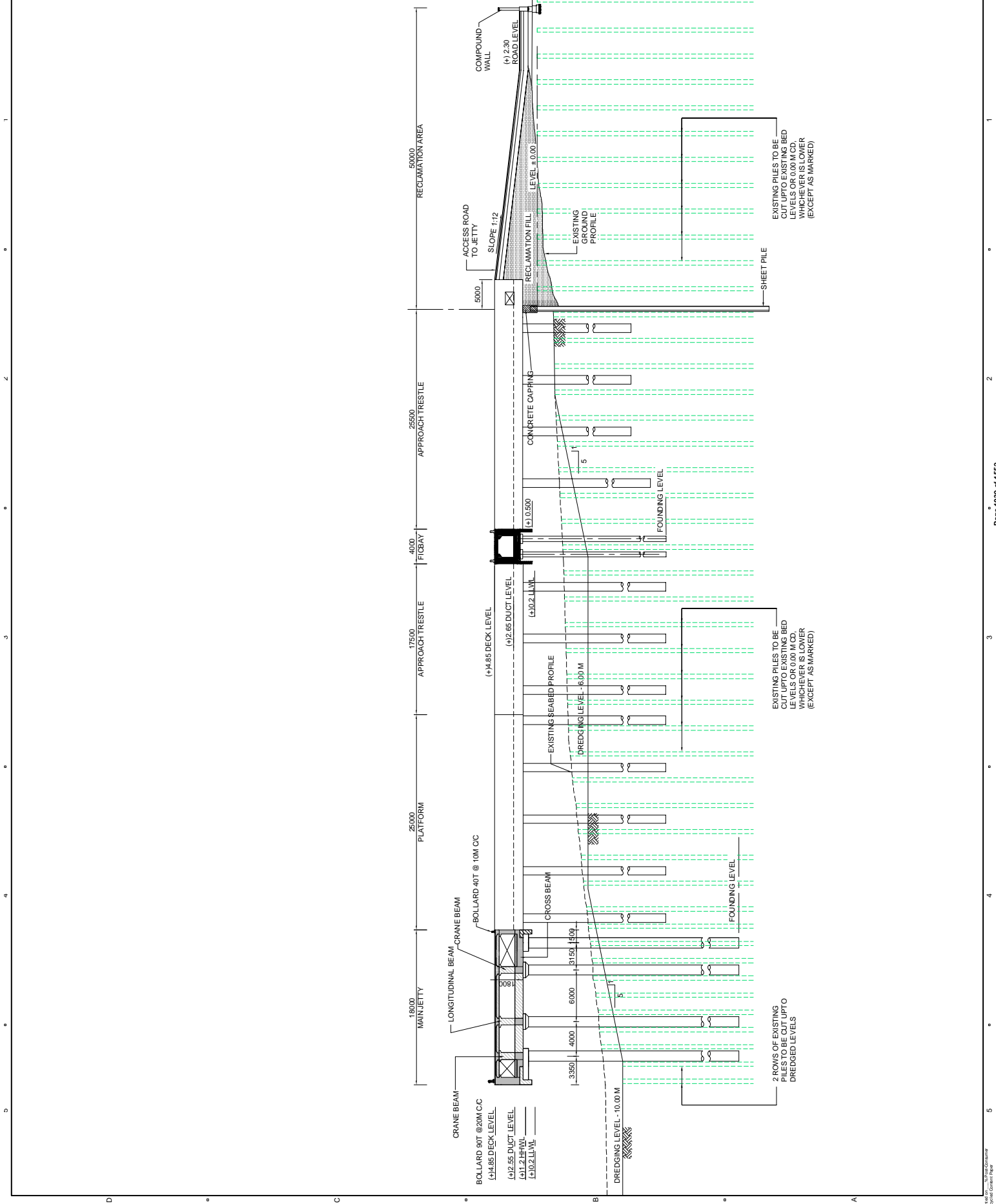
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-1002
 REV: 0

SHEET 01 OF 01

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REVISIONS	DATE	REVISION DETAILS	DRN	CHK	APP
ISSUED FOR TENDER					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS OF THE DRAWING: DIMENSIONS ARE IN METERS					
PURPOSE:					
DRAWING TITLE: CROSS SECTION OF DREDGING AREA					
SHEET: 01 OF 01					
REV: 0					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-1003					



NOTES:
 1 ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SPECIFIED
 3 ALL COORDINATES ARE GIVEN IN METRES RELATING TO UTM PROJECTION, SPHEROID WGS 84

PROJECT MANAGEMENT: [REDACTED] DESIGNER: SV CHECKED: SS APPROVED: SS ISO A1 594mm x 841mm

FILE NAME: \\AECOM\Projects\2020\01-08\18014746-DWG-PL-1004\18014746-DWG-PL-1004.DWG LAST PLOTTED: 2020-01-08

PLANT FILE: \\AECOM\Projects\2020\01-08\18014746-DWG-PL-1004\18014746-DWG-PL-1004.DWG

PHOTOPLOT: [REDACTED] PLOT DATE: [REDACTED] PLOT TIME: [REDACTED]

REVISIONS: [REDACTED]

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPANTS: [REDACTED]
 PURPOSE: [REDACTED]
 DRAWING TITLE: [REDACTED]

REVISION NUMBER: [REDACTED]
 DRAWING NUMBER: 80814746-DWG-PL-1004
 REV: 0

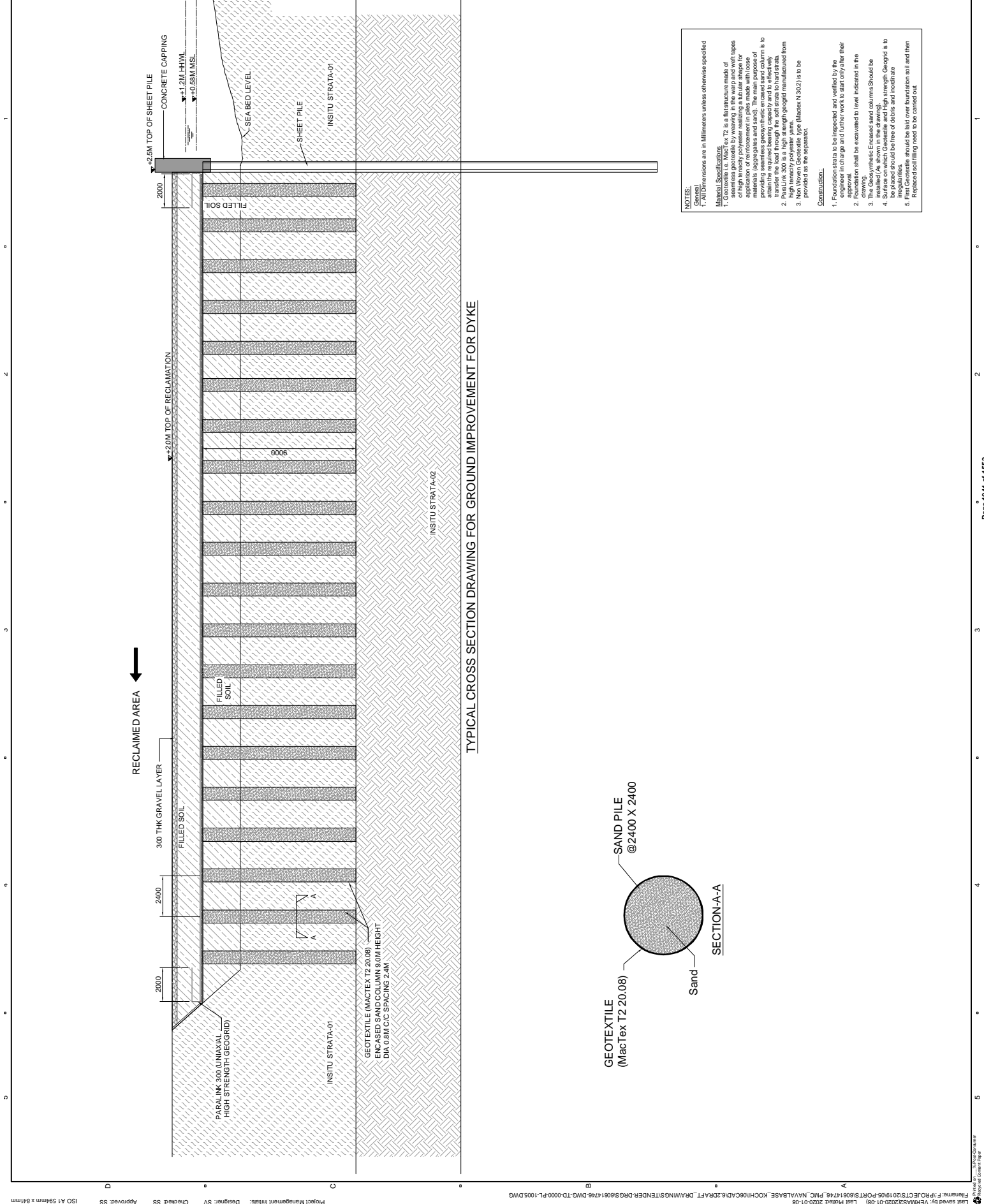
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ISSUED FOR TENDER

DETAIL LAYOUT OF THE NORTH JETTY COMPONENTS

AECOM India Pvt. Ltd.

REV	DATE	REVISION	DR	CHK	APP
ISSUED FOR TENDER					
COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE:					
DRAWING NUMBER: 80614746-DWG-TD-0000-PL-1005					
DRAWING TITLE: DETAILS OF SHEET PILE WALL AND GROUND IMPROVEMENTS					
DRAWING NUMBER: 80614746-DWG-TD-0000-PL-1005					
REV: 0					



NOTES:

1. All Dimensions are in Millimetres unless otherwise specified.

Material Specifications:

1. Geotextile (MacTex T2 20.08) is a flat woven fabric made of seamless geotextile by weaving in the warp and weft tapes of high tenacity polyester realizing a tubular shape for application of reinforcement in piles made with loose soil. The geotextile is encased in sand column to provide seamless geosynthetic encased sand column to attain the required bearing capacity and to effectively resist the lateral movement of soil.

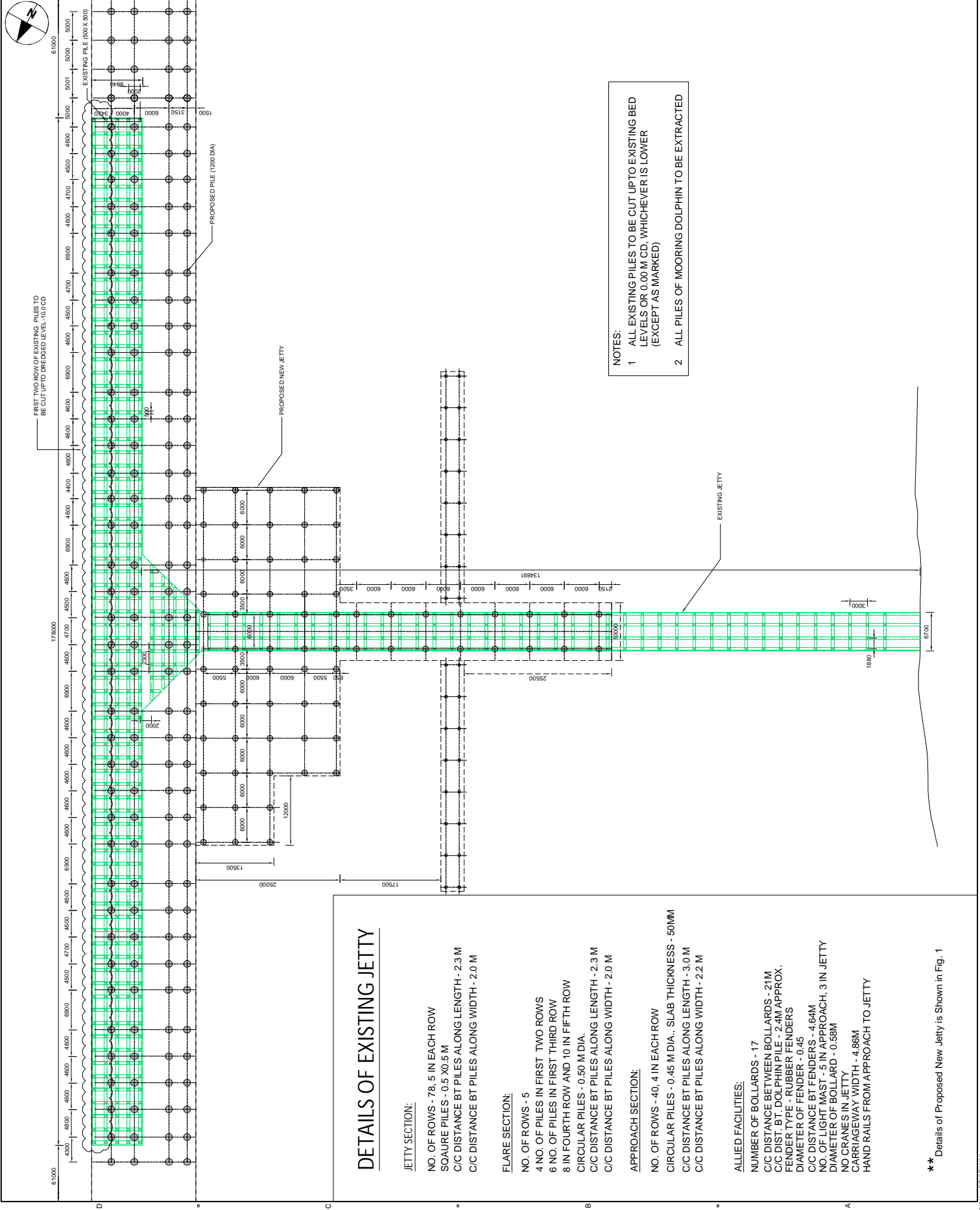
2. Paralink 300 is a high strength geogrid manufactured from high tenacity polyester yarns.

3. Non Woven Geotextile type (MacTex N.302) is to be provided as the separator.

Construction:

- Foundation starts to be inspected and verified by the engineer in charge and further work to start only after their approval.
- Excavation shall be excavated to level indicated in the drawing.
- The Geosynthetic Encased sand columns should be installed in the excavation and the sand should be placed on which Geotextile and high strength Geogrid is to be placed should be free of debris and inordinate impurities. The sand should be laid over foundation soil and then Replaced soil filling need to be carried out.

NOTES:
 1 ALL DIMENSIONS ARE MILLIMETER AND LEVELS ARE IN METER AND WITH REFERENCE TO CHART DATUM



NOTES:
 1 ALL EXISTING PILES TO BE CUT UP TO EXISTING BED LEVELS OR 0.00 M CD, WHICHEVER IS LOWER (EXCEPT AS MARKED)
 2 ALL PILES OF MOORING DOLPHIN TO BE EXTRACTED

DETAILS OF EXISTING JETTY

JETTY SECTION:

- NO. OF ROWS - 78, 5 IN EACH ROW
- SQUARE PILES - 0.5 X 0.5 M
- C/C DISTANCE BT PILES ALONG LENGTH - 2.3 M
- C/C DISTANCE BT PILES ALONG WIDTH - 2.0 M

FLARE SECTION:

- NO. OF ROWS - 5
- 4 NO. OF PILES IN FIRST TWO ROWS
- 6 NO. OF PILES IN FIRST THIRD ROW
- 8 IN FOURTH ROW AND 10 IN FIFTH ROW
- CIRCULAR PILES - 0.50 M DIA
- C/C DISTANCE BT PILES ALONG LENGTH - 2.3 M
- C/C DISTANCE BT PILES ALONG WIDTH - 2.0 M

APPROACH SECTION:

- NO. OF ROWS - 40, 4 IN EACH ROW
- CIRCULAR PILES - 0.45 M DIA., SLAB THICKNESS - 50MM
- C/C DISTANCE BT PILES ALONG LENGTH - 3.0 M
- C/C DISTANCE BT PILES ALONG WIDTH - 2.2 M

ALLIED FACILITIES:

- NUMBER OF BOLLARDS - 17
- C/C DISTANCE BETWEEN BOLLARDS - 21M
- C/C DIST BT DOLPHIN PILE - 2.4M APPROX.
- FENDER TYPE - RUBBER FENDERS
- DIAMETER OF FENDER - 0.45
- C/C DISTANCE BT FENDERS - 4.64M
- NO. OF LIGHT MAST - 5 IN APPROACH, 3 IN JETTY
- DIAMETER OF BOLLARD - 0.58M
- NO CRANES IN JETTY
- CARRIAGEWAY WIDTH - 4.86M
- HAND RAILS FROM APPROACH TO JETTY

*** Details of Proposed New Jetty is Shown in Fig. 1

ISSUED FOR TENDER

NO.	DATE	REVISION	BY	CHKD	APPD
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS: DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE: SUPERIMPOSED DRAWING OF PROPOSED JETTY OVER EXISTING NORTH JETTY					
DRAWING NUMBER: 80814746-DWG-TD-0000-CS-2000					
REV.	0				

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NOTES:
 1 ALL DIMENSIONS ARE MILLIMETER AND LEVELS ARE IN METER AND WITH REFERENCE TO CHART DATUM

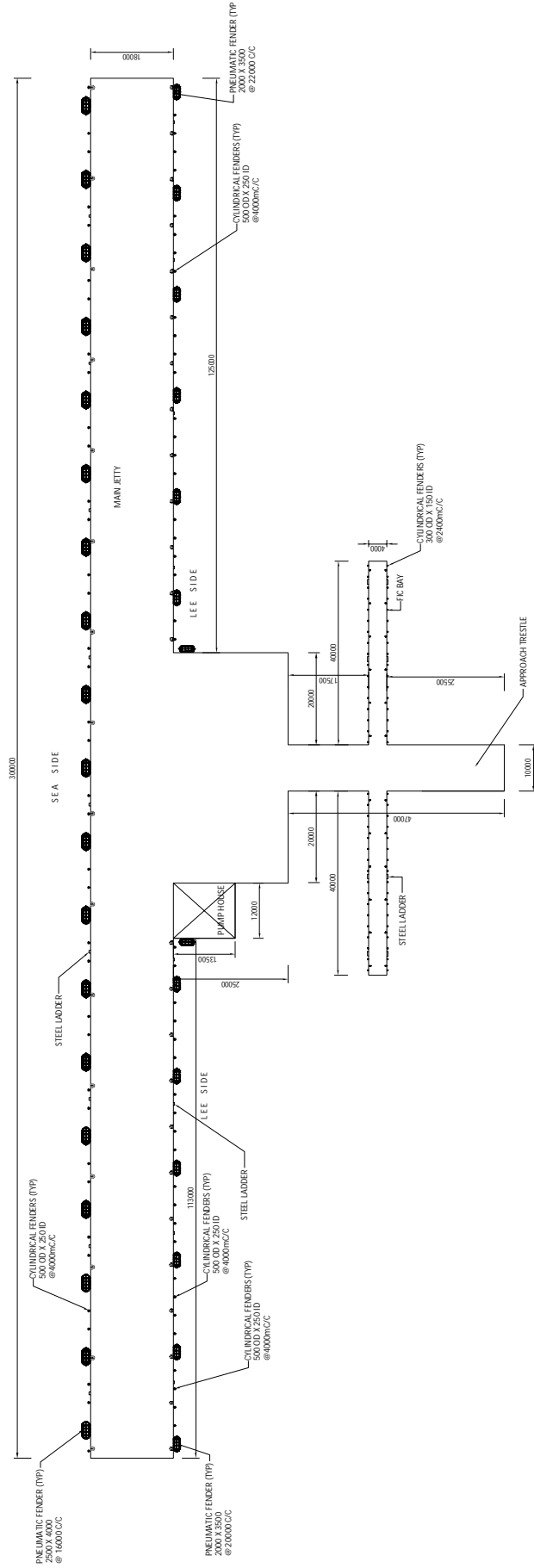


TABLE FOR FENDERS:

JETTY / SIDE	VESSEL BERTHED	TYPE OF FENDER	SIZE OF FENDER (DIA. IN mm X LENGTH IN mm)	SPACING OF FENDERS (m)	NOS. OF FENDERS
MAIN JETTY / SEA SIDE	IAC VIKRANT + FUEL BASE	PNEUMATIC	2500 X 4000	16.00	19
		CYLINDRICAL	500 OD X 250 ID	4.00	38
MAIN JETTY / LEE SIDE	UPTO 3000T NAVAL VESSELS	PNEUMATIC	2000 X 3500	20.00 / 22.00	14
		CYLINDRICAL	500 OD X 250 ID	4.00	44
FIC BAY		CYLINDRICAL	300 OD X 150 ID	2.40	68

TABLE FOR BOLLARD:

JETTY / SIDE	TYPE OF BOLLARD	SPACING OF BOLLARD (m)	NOS. OF BOLLARD
MAIN JETTY / SEA SIDE	90 T BOLLARD	20.00	16
MAIN JETTY / LEE SIDE	40 T BOLLARD	10.00	25
FIC BAY	2 T BOLLARD	8.00	24

DETAILS OF APPROACH RESTLE

DECK LEVEL = +4.85
 SLAB THICKNESS = 300mm
 LENGTH X WIDTH OF MAIN JETTY = 17m X 10m
 CROSS BEAM DIMENSIONS = 1000mm X 1000mm
 SEA FACE BEAM DIMENSIONS = 500mm X 2800mm
 LEE FACE BEAM DIMENSIONS = 500mm X 2800mm
 CIRCULAR PILES = 1000MM DIA. (2PCS IN EACH ROW)
 PILE MUF ON SEA FACE PILE = 2400MM X 2400MM X 500MM
 BOTTOM LEVEL = -0.3M

DETAILS OF FIC BAY

DECK LEVEL = +4.85
 SLAB THICKNESS = 300mm
 LENGTH X WIDTH OF FIC BAY = 40m X 4m
 CROSS BEAM DIMENSIONS = 500mm X 750mm
 SEA FACE BEAM DIMENSIONS = 1000mm X 2800mm
 LEE FACE BEAM DIMENSIONS = 500mm X 2500mm
 CIRCULAR PILES = 750MM DIA. (2PCS IN EACH ROW)
 PILE MUF ON SEA FACE PILE = 1100MM X 1100MM X 500MM
 STEEL LADDER = 2 INES ON EACH SIDE (3000MM WIDE)
 BOTTOM LEVEL = -0.3M

DETAILS OF MAIN JETTY

DECK LEVEL = +4.85
 SLAB THICKNESS = 400mm
 LENGTH X WIDTH OF MAIN JETTY = 300m X 18m
 CROSS BEAM DIMENSIONS = 1000mm X 1000mm
 SEA FACE BEAM DIMENSIONS = 500mm X 2800mm
 LEE FACE BEAM DIMENSIONS = 500mm X 2800mm
 CIRCULAR PILES = 1000MM DIA. (2PCS IN EACH ROW)
 PILE MUF ON SEA FACE PILE = 3600MM X 3600MM X 500MM
 STEEL LADDER = 2 INES ON EACH SIDE (3000MM WIDE)
 BOTTOM LEVEL = -0.3M

ISSUED FOR TENDER

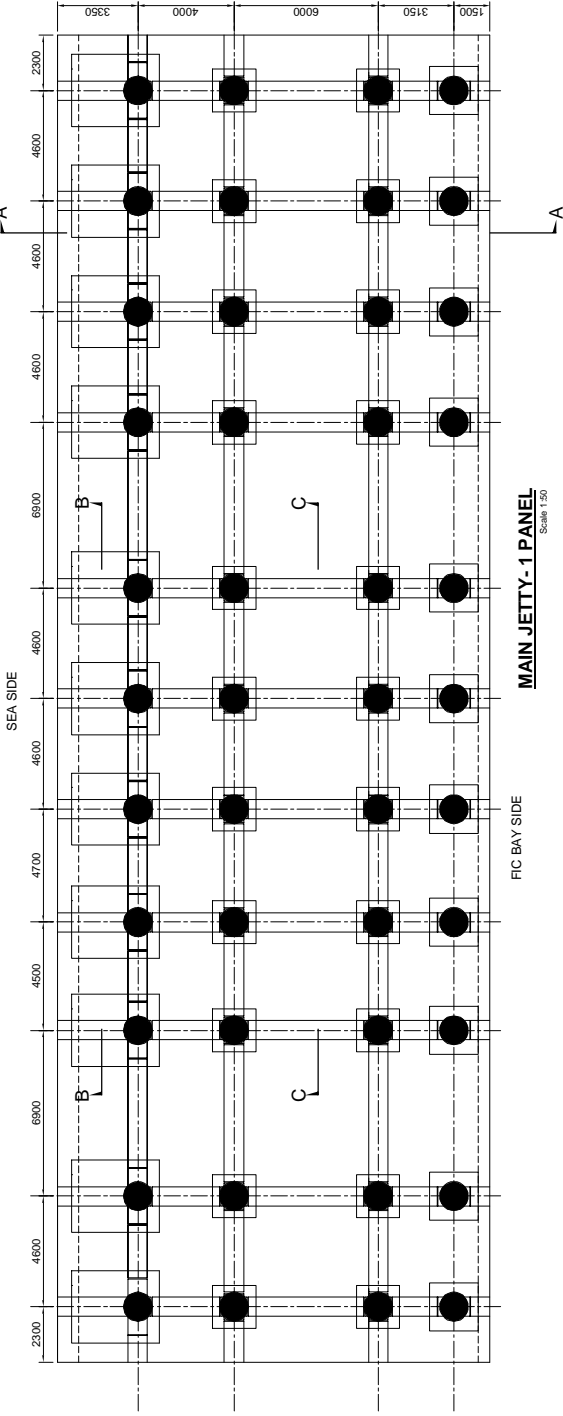
REV.	DATE	REVISION	DR.	CHK.	APP.

REVISION DETAILS

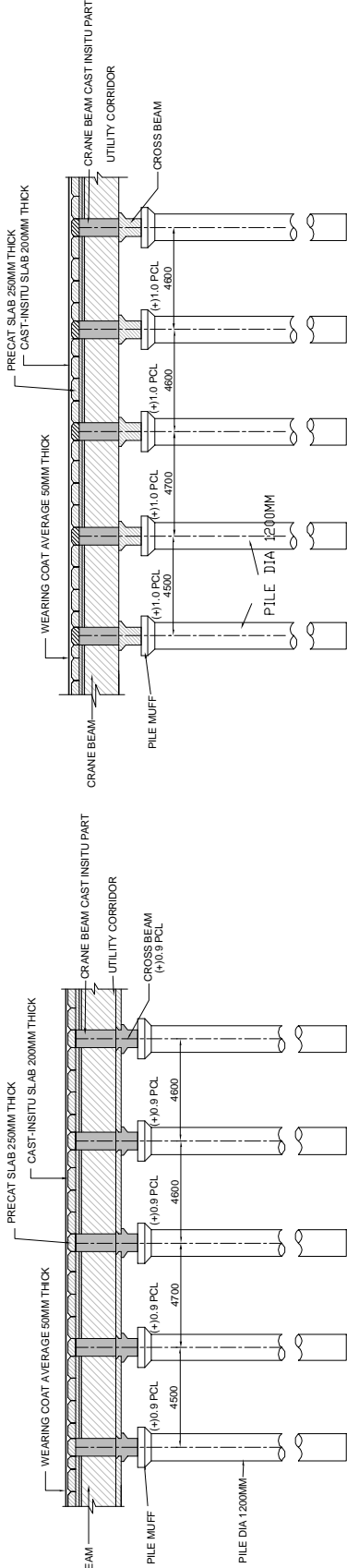
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 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPANTS: AECOM
 DIMENSIONS ARE IN: METER
 DRAWING TITLE: OVERALL PLAN OF MAIN JETTY
 DRAWING NUMBER: 80614746-DWG-TD-0000-CS-2001
 REV: 0



NOTES:
 ALL DIMENSIONS ARE MILLIMETER AND LEVELS ARE IN METER AND WITH REFERENCE TO CHART DATUM

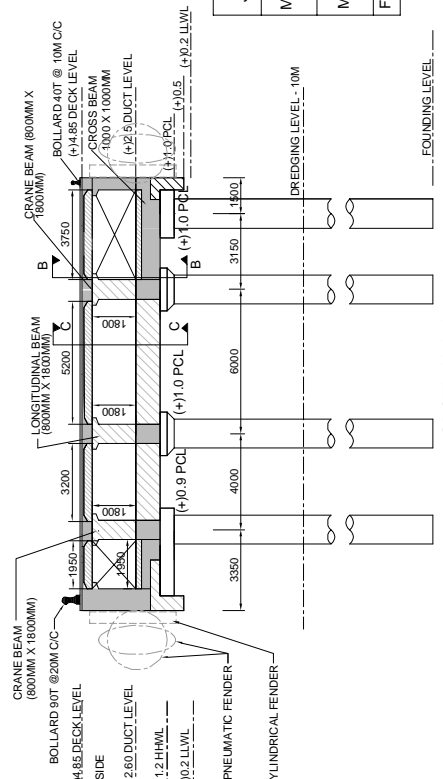


MAIN JETTY - 1 PANEL
 Scale 1:50



SECTION B-B
 Scale 1:50

SECTION C-C
 Scale 1:50



SECTION A-A
 Scale 1:50

JETTY / SIDE	VESSEL BERTHED	TYPE OF FENDER	SIZE OF FENDER (DIA. IN mm X LENGTH IN mm)	SPACING OF FENDERS (m)	NOS. OF FENDERS
MAIN JETTY / SEA SIDE	IAC VIKRANT + FUEL BASE	PNEUMATIC	2500 X 4000	16.00	19
		CYLINDRICAL	500 OD X 250 ID	4.00	38
MAIN JETTY / LEE SIDE	UPTO 3000T NAVAL VESSELS	PNEUMATIC	2000 X 3500	20.00 / 22.00	14
		CYLINDRICAL	500 OD X 250 ID	4.00	44
FIC BAY		CYLINDRICAL	300 OD X 150 ID	2.40	68

ISSUED FOR TENDER

REV.	DATE	DESCRIPTION	BY	CHK.	APP.
REVISION DETAILS					

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PART/DISCIPLINE: DIMENSIONS PART
 PURPOSE:
 DRAWING TITLE: MAIN JETTY PLAN AND CROSS SECTION
 DRAWING NUMBER: 80014746-DWG-TD-0000-CS-2002
 REV: 0

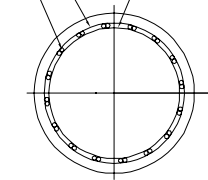
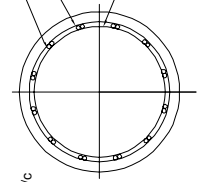
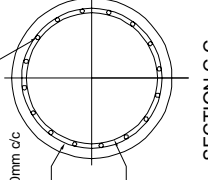
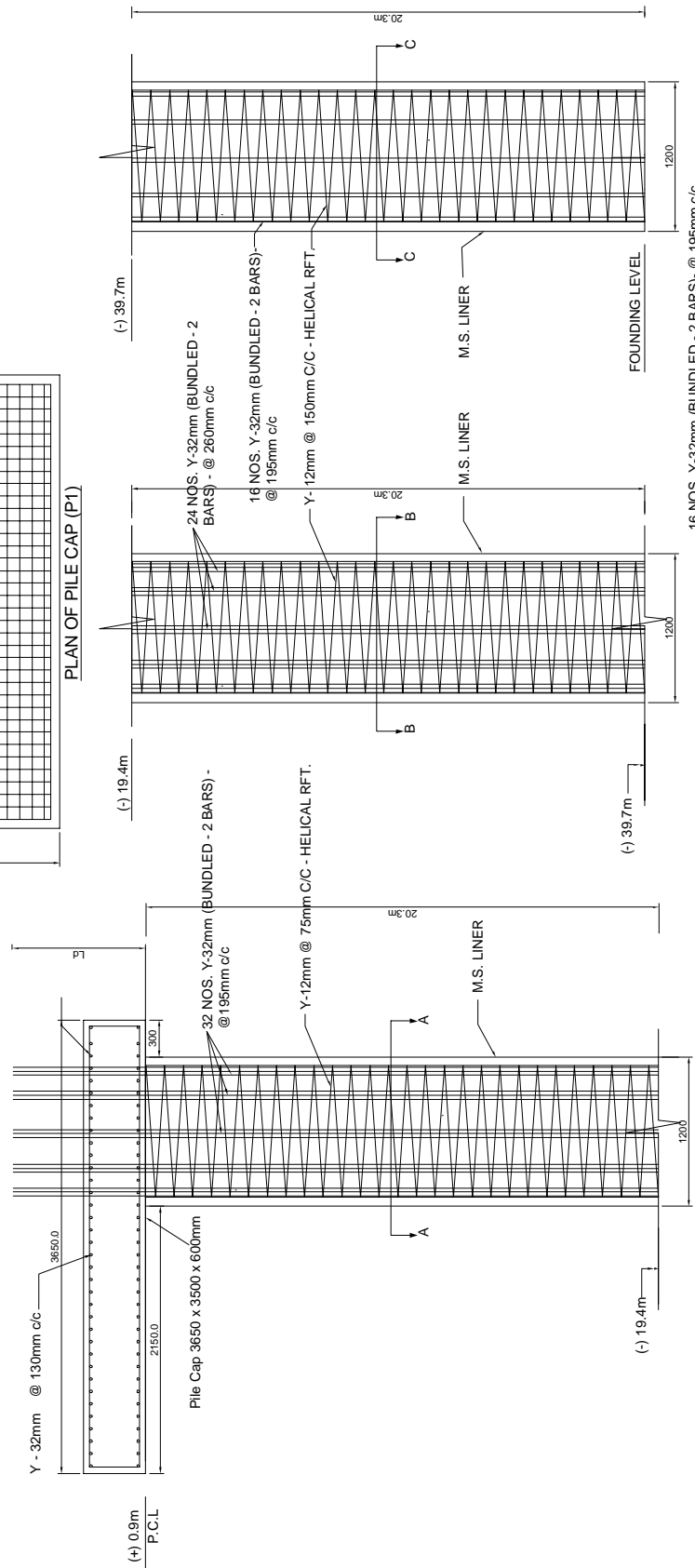
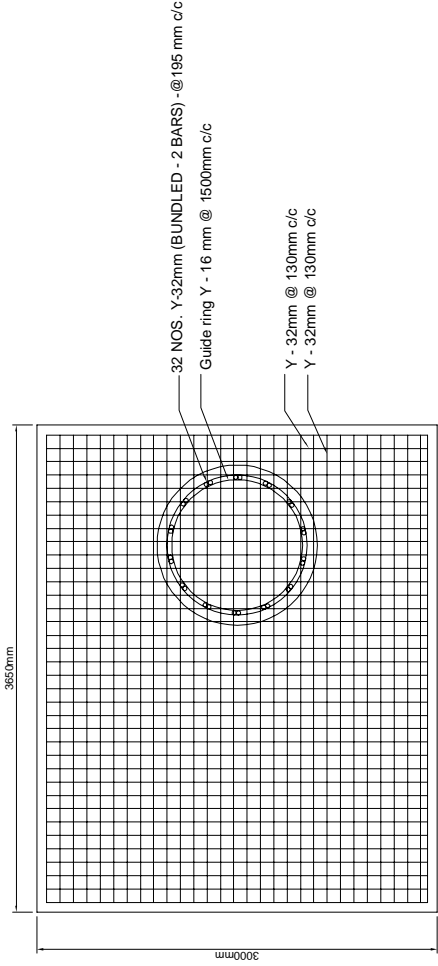
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- NOTES:**
- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND DIMENSIONS IN PARENTHESES ARE IN METERS (m) UNLESS OTHERWISE SPECIFIED.
 - 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE CHECKED BEFORE LAYING SOIL AND LINER WORKS.
 - 3 UNLESS NOTED OTHERWISE LAP LENGTH, DEVELOPMENT LENGTH (LD) OF BARS SHALL BE MIN. 40 TIMES THE DIA OF BARS. ONLY 50% OF THE BARS SHALL BE STAGGERED AT A DISTANCE OF MINIMUM 1.30 TIMES LD APART.

ISSUED FOR TENDER

REV	DATE	DESCRIPTION	DRG. CHK.	APP.
		REVISION DETAILS		

OWNER: COCHIN PORT TRUST
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
PARTICULARS: DIMENSIONS ARE IN METERS
PURPOSE: RECONSTRUCTION
DRAWING TITLE: MAIN JETTY REINFORCEMENT DETAILS OF PILE
DRAWING NUMBER: 80014746-DWG-TD-0000-CS-2003
REV: 0



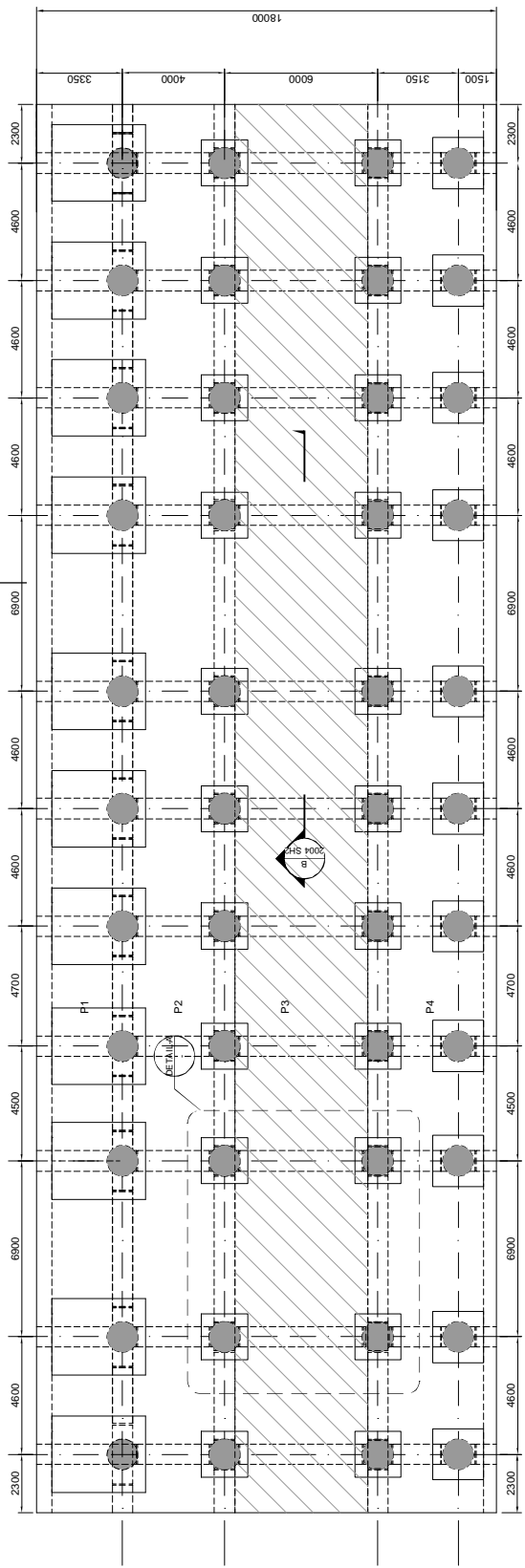
SECTION C-C

SECTION B-B

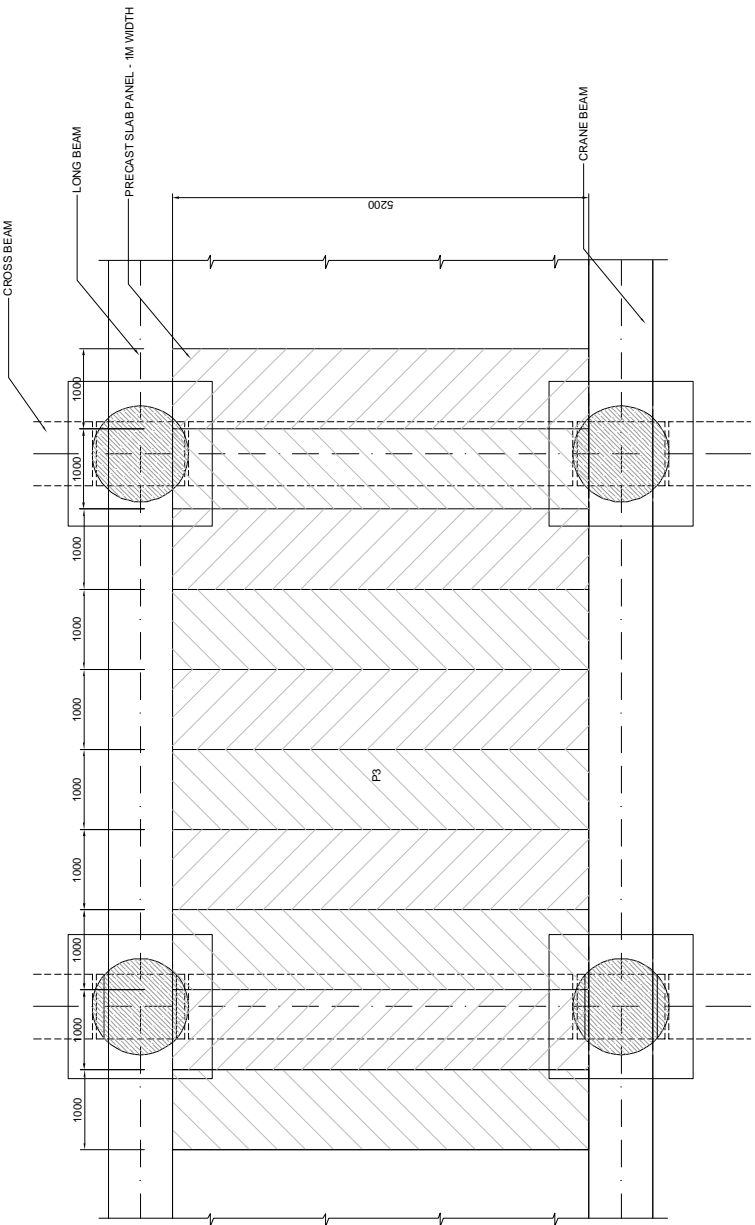
SECTION A-A

NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS (mm) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc SHALL BE BEFORE LAYING SOIL AND LATER WORKS.



LAYOUT OF PRECAST SLAB
Scale 1:100



DETAIL A - LAYOUT OF PRECAST PANEL @1M WIDTH.

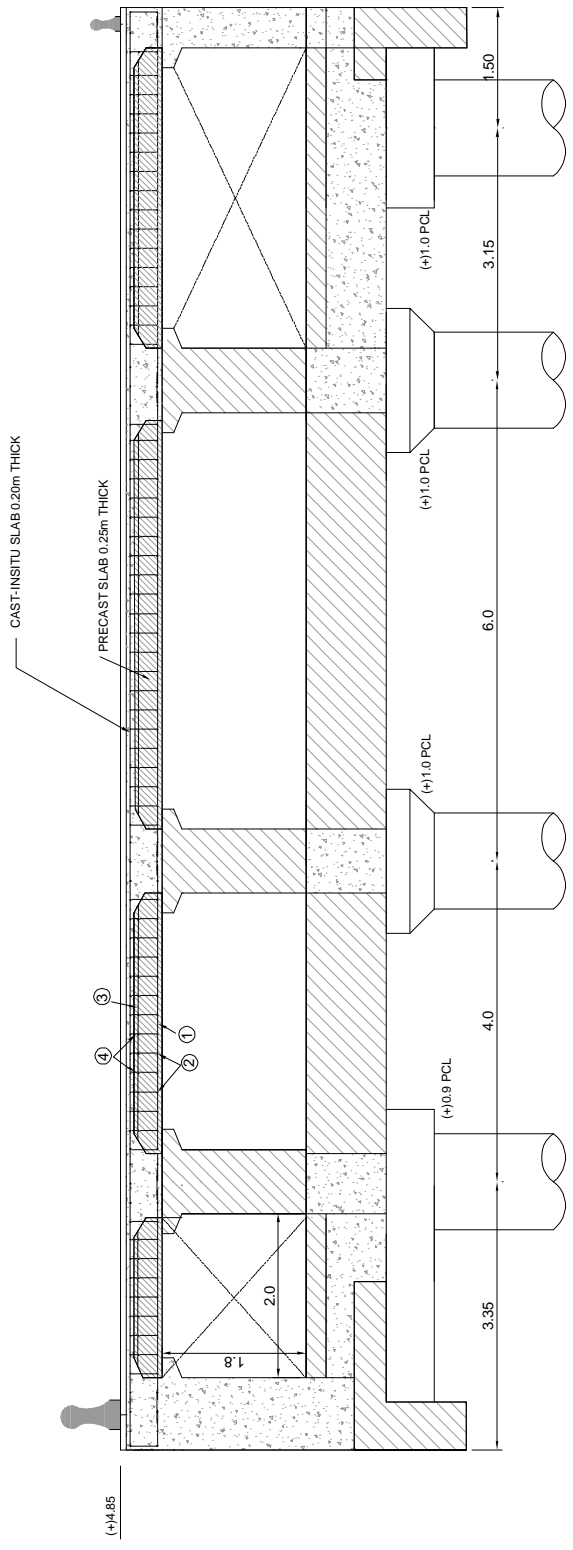
ISSUED FOR TENDER

REV	DATE	DESCRIPTION	BY	CHECKED
REVISION DETAILS				
OWNER: COCHIN PORT TRUST				
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI				
PARTICULARS ARE IN DIMENSIONS ARE IN				
PURPOSE:				
DRAWING TITLE: MAIN JETTY LAYOUT OF PRECAST SLAB AND REINFORCEMENT DETAILS (SHEET 1)				
DRAWING NUMBER: 80814746-DWG-TD-0000-CS-2004				
REV: 0				

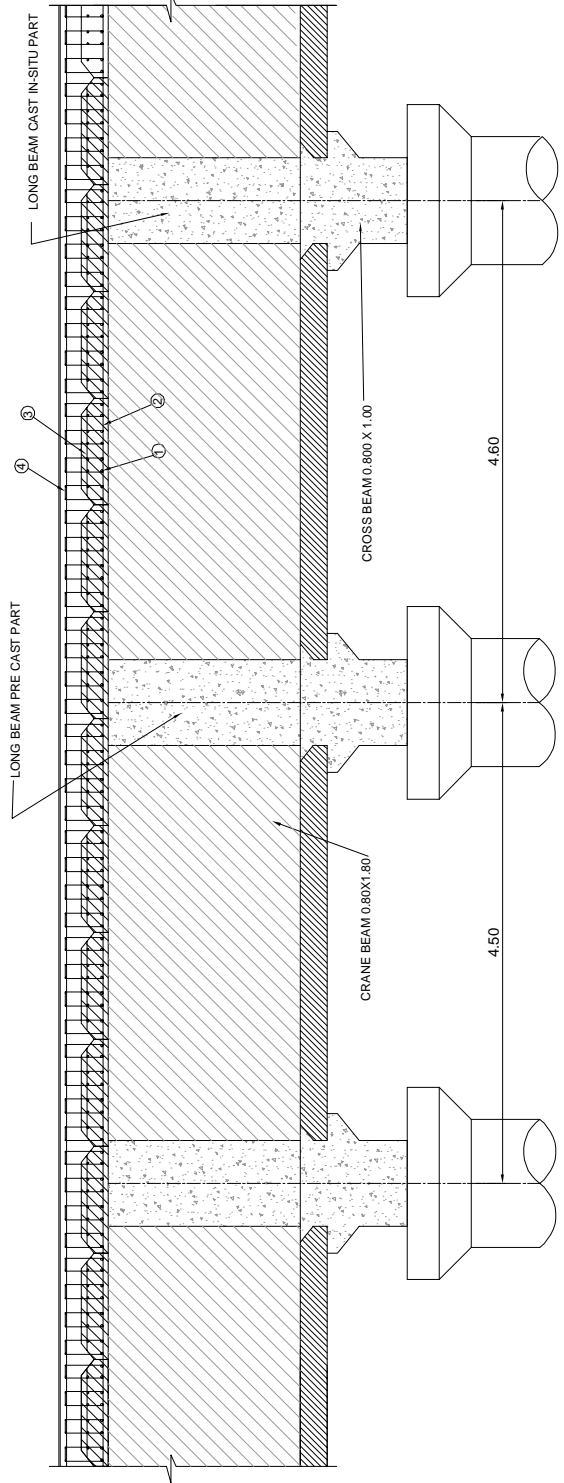


NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND ARE UNLESS SPECIFIED OTHERWISE.
- 2 DIMENSIONS LEVELS, SLOPES etc. SHALL BE BEFORE LAYING SOIL AND LINER WORKS.
- 3 UNLESS NOTED OTHERWISE LAP LENGTH, DEVELOPMENT LENGTH (LD) OF BARS SHALL BE MIN. 40 TIMES THE DIA OF BARS. ONLY 50% OF BARS SHALL BE STAGGERED AT A DISTANCE OF MINIMUM 1.30 TIMES L_d APART.



SECTION A-A



SECTION B-B

BAR MARK	DETAILS	REMARKS
①	Y-25 @ 130mmcc	Main Rt.
②	Y-12 @ 240mmcc	Distribution steel
③	Y-12 @ 200mmcc	Pre-cast top
④	Y-12 @ 150mmcc	Straps

ISSUED FOR TENDER

NO.	DATE	DESCRIPTION	BY	CHKD.	APP.

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPATING AGENCY: DIMENSIONS ARE IN

SHEET	NO.	TOTAL
02	02	02

DRAWING TITLE: MAIN JETTY LAYOUT OF PRECAST SLAB AND REINFORCEMENT DETAILS (SHEET 2)
 DRAWING NUMBER: 80014746-DWG-TD-0000-CS2004
 REV: 0



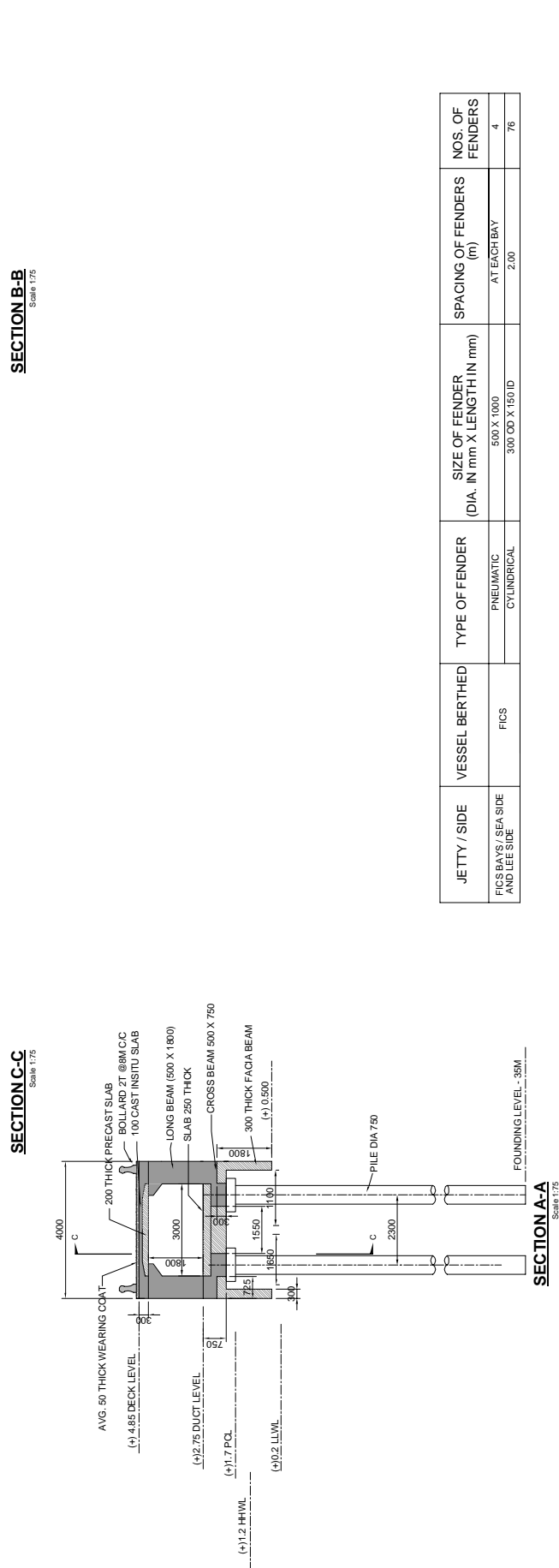
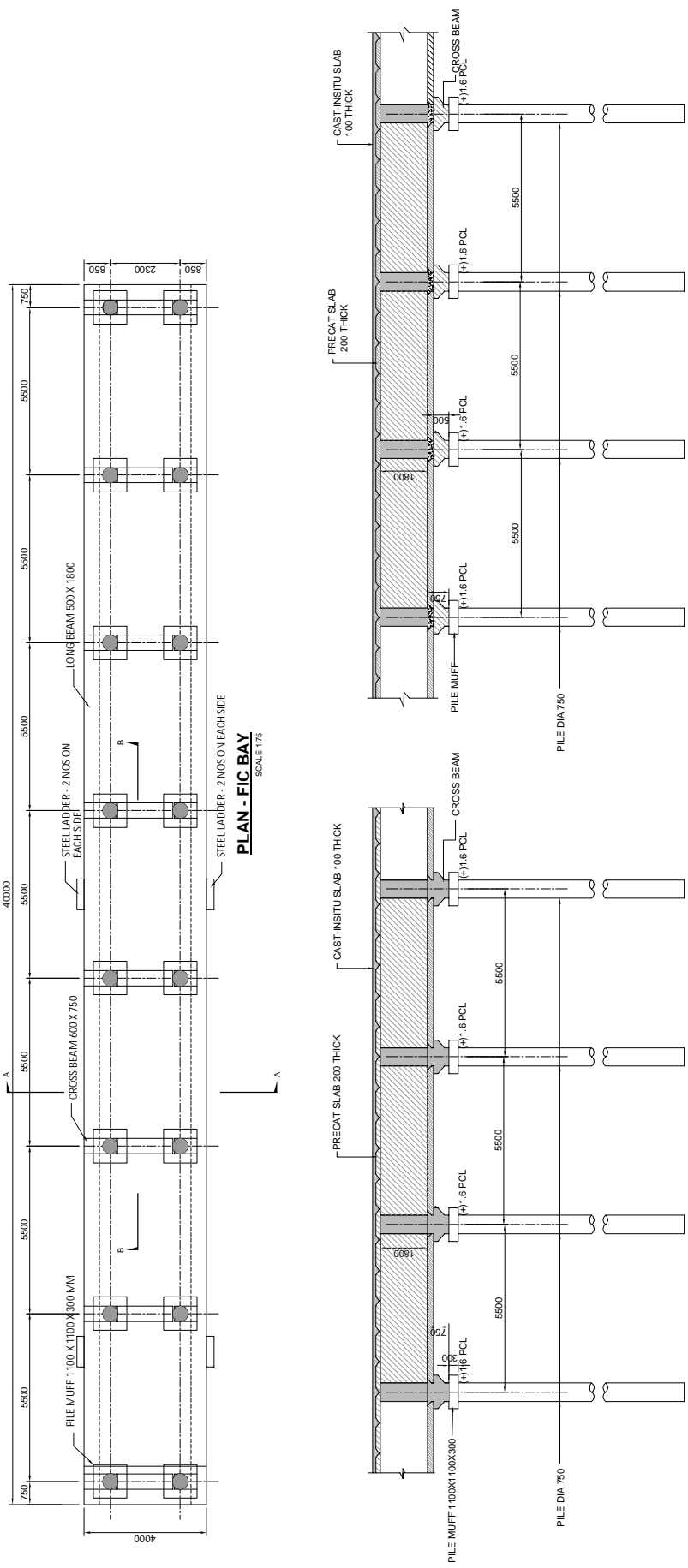
NOTES:
 ALL DIMENSIONS ARE MILLIMETER AND LEVELS ARE IN METER WITH RESPECT TO CHART DATUM

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ISSUED FOR TENDER

REV.	DATE	REVISION	DR.	CHK.	APP.
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RE-CONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS: DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE: FIC BAY PLAN AND CROSS SECTION					
DRAWING NUMBER: 80614746-DWG-TD-0000-CS-2005					
REV.	0				
SHEET 01 OF 01					

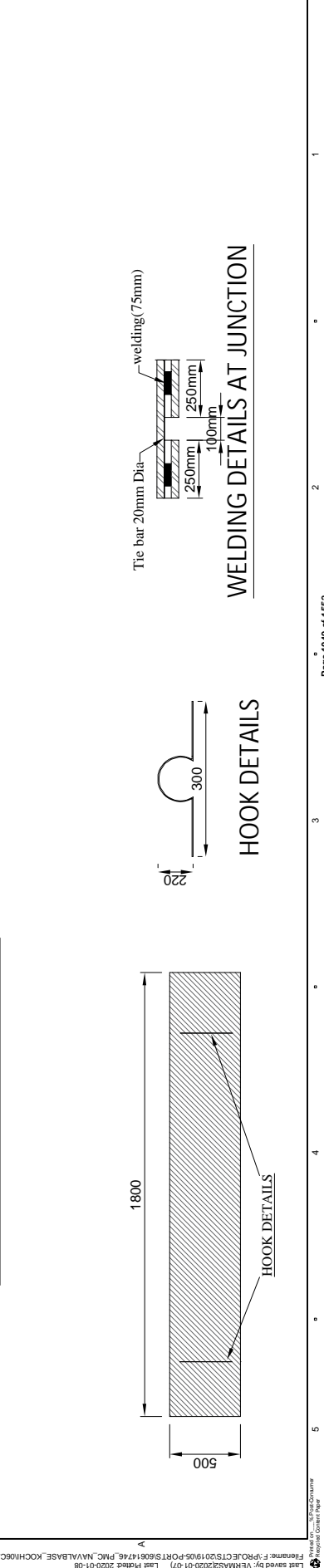
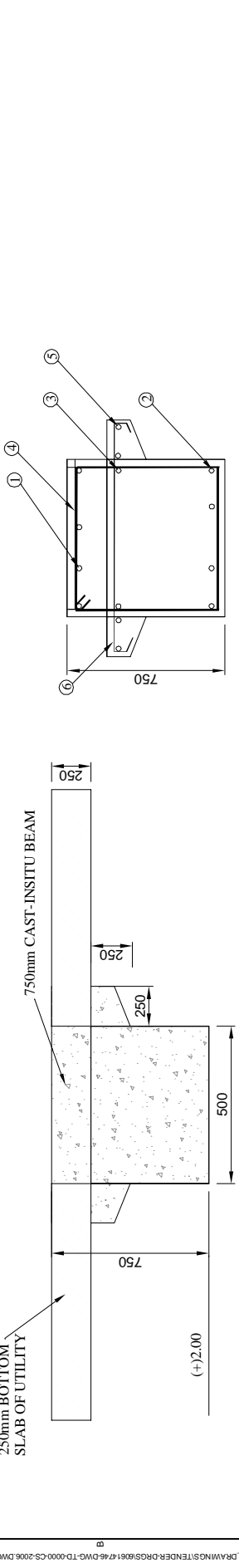
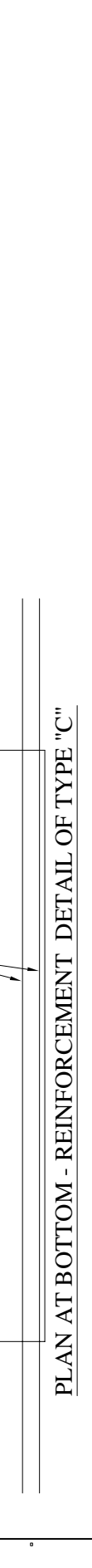
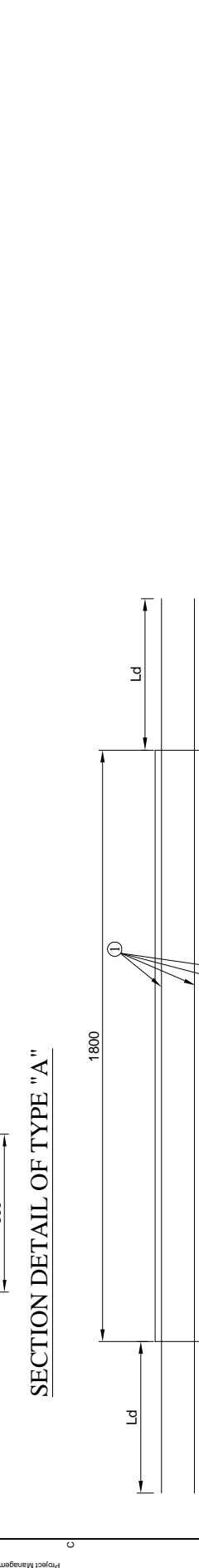
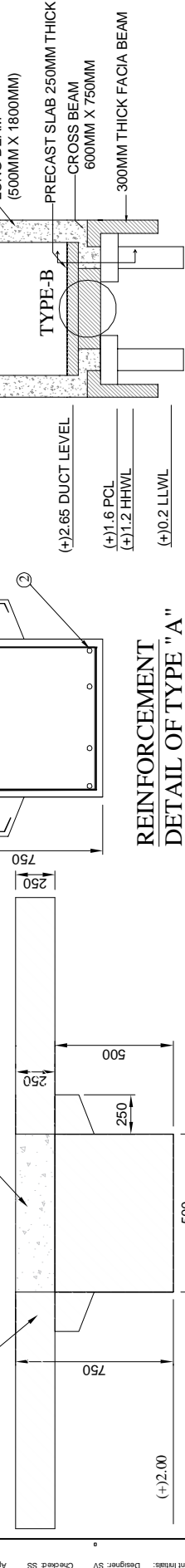
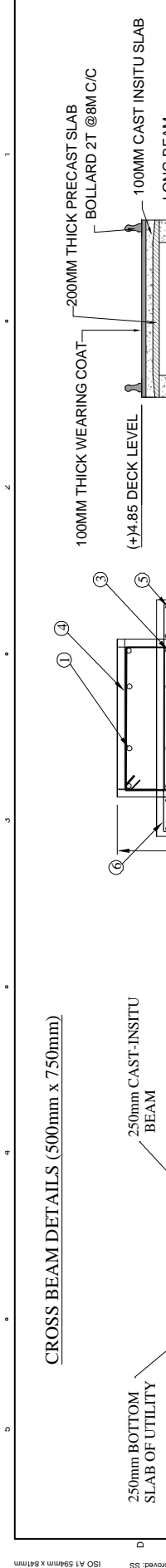
AECOM
 AECOM India Pvt. Ltd.



JETTY / SIDE	VESSEL BERTHED	TYPE OF FENDER	SIZE OF FENDER (DIA. IN mm X LENGTH IN mm)	SPACING OF FENDERS (m)	NOS. OF FENDERS
FICS BAYS / SEA SIDE AND LEE SIDE	FICS	PNEUMATIC CYLINDRICAL	500 X 1000 300 OD X 150 ID	AT EACH BAY 2.00	4 76

NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND LEVELS ARE IN METERS (m) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.
- 3 UNLESS NOTED OTHERWISE LAP LENGTH SHALL BE 40 TIMES THE DIA OF BARS. ONLY 50% OF BARS SHALL BE LAPED AT A SECTION. LAPS SHALL BE STAGGERED AT A MINIMUM OF 1.30 TIMES LAP PART.



REV	DATE	DESCRIPTION	DR	CHK	APP

ISSUED FOR TENDER

OWNER: COCHIN PORT TRUST

PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI

PARTICULARS:

PURPOSE:

DRAWING TITLE: DETAILS OF CROSS BEAMS

DRAWING NUMBER: 60614746-DWG-TD-0000-CS-2006

REV: 0

SCALE:

DATE:

BY:

CHK:

APP:

REINFORCEMENT DETAILS OF CROSS BEAMS- TYPE A

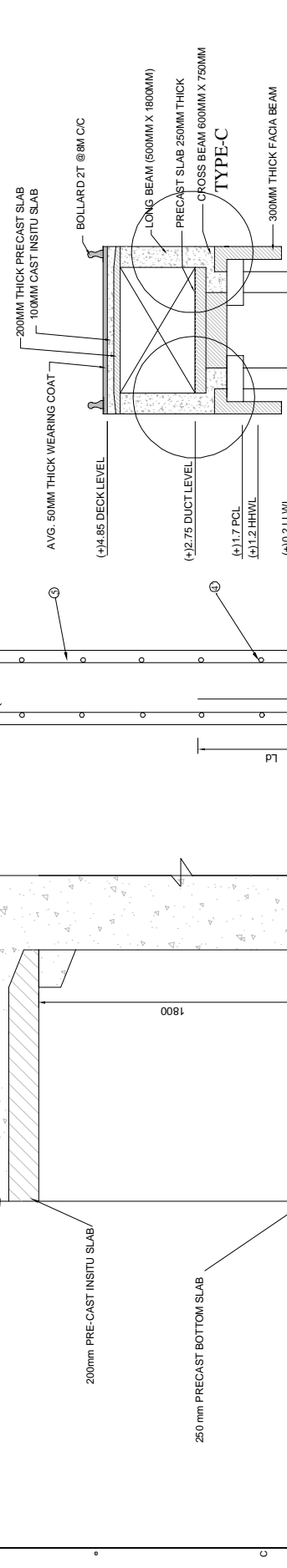
BAR MARK	TYPE/DIAMETER	REMARKS
1	4 nos. Y-25	Main Reinforcement Top
2	4 nos. Y-25	Main Reinforcement Top
3	4 nos. Y-20	Pre Cast Top
4	2L-Y12 @200mm c/c	Stirrups
5	2 nos. - Y25 on each	Corbel
6	Y12 @250mm c/c	Links

REINFORCEMENT DETAILS OF CROSS BEAMS- TYPE B

BAR MARK	TYPE/DIAMETER	REMARKS
1	4 nos. Y-25	Main Reinforcement Top
2	4 nos. Y-25	Main Reinforcement Top
3	2 nos. Y-25	Supporting bar for corbel
4	2L-Y12 @200mm c/c	Stirrups
5	2 nos. - Y25 on each	Corbel
6	Y12 @250mm c/c	Links

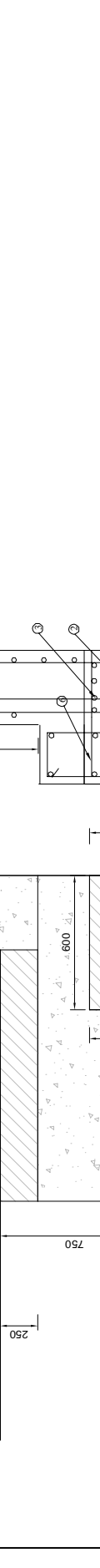
- NOTES:**
- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND LEVELS ARE IN METERS (m) UNLESS OTHERWISE SPECIFIED.
 - 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOL AND LINER WORKS.
 - 3 UNLESS OTHERWISE SPECIFIED, DEVELOPMENT LENGTH OF BARS SHALL BE MIN. 40 TIMES THE DIA OF BARS. ONLY 50% OF THE BARS SHALL BE STAGGERED AT A DISTANCE OF MINIMUM 1.30 TIMES LAP PART.

BAR MARK	TYPEDIAMETER	REMARKS
1	5 nos. Y-25	Main Reinforcement Top
2	5 nos. Y-25	Main Reinforcement Bottom
3	5 nos. Y-25	Pre-Cast Top/Pre-Cast Bottom
4	Y-25 @ 200mm c/c	Face Slab Reinforcement
5	Y-20 @ 100mm c/c	Reinforcement Slab Duct Level (From Duct Level to Top)
6	2xY12 @ 250mm c/c	Strips
	Y12 @ 250mm c/c	Links

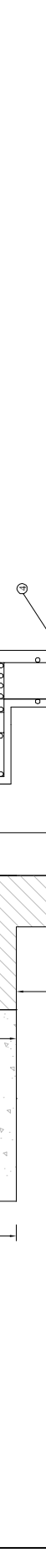


SECTION DETAIL OF TYPE "C"

SECTION DETAIL OF TYPE "C"

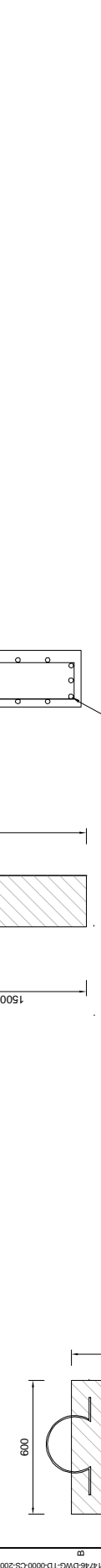


PLAN AT BOTTOM - REINFORCEMENT DETAIL OF TYPE "C"



HOOK DETAILS

HOOK DETAILS



WELDING DETAILS AT JUNCTION

WELDING DETAILS AT JUNCTION

NO.	DATE	REVISIONS	DR. CHG.	APP.
		REVISION DETAILS		

ISSUED FOR TENDER

OWNER: **COCHIN PORT TRUST**

PROJECT: **PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI**

PARTICULARS: _____

PURPOSE: _____

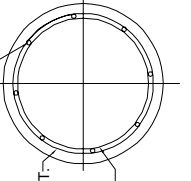
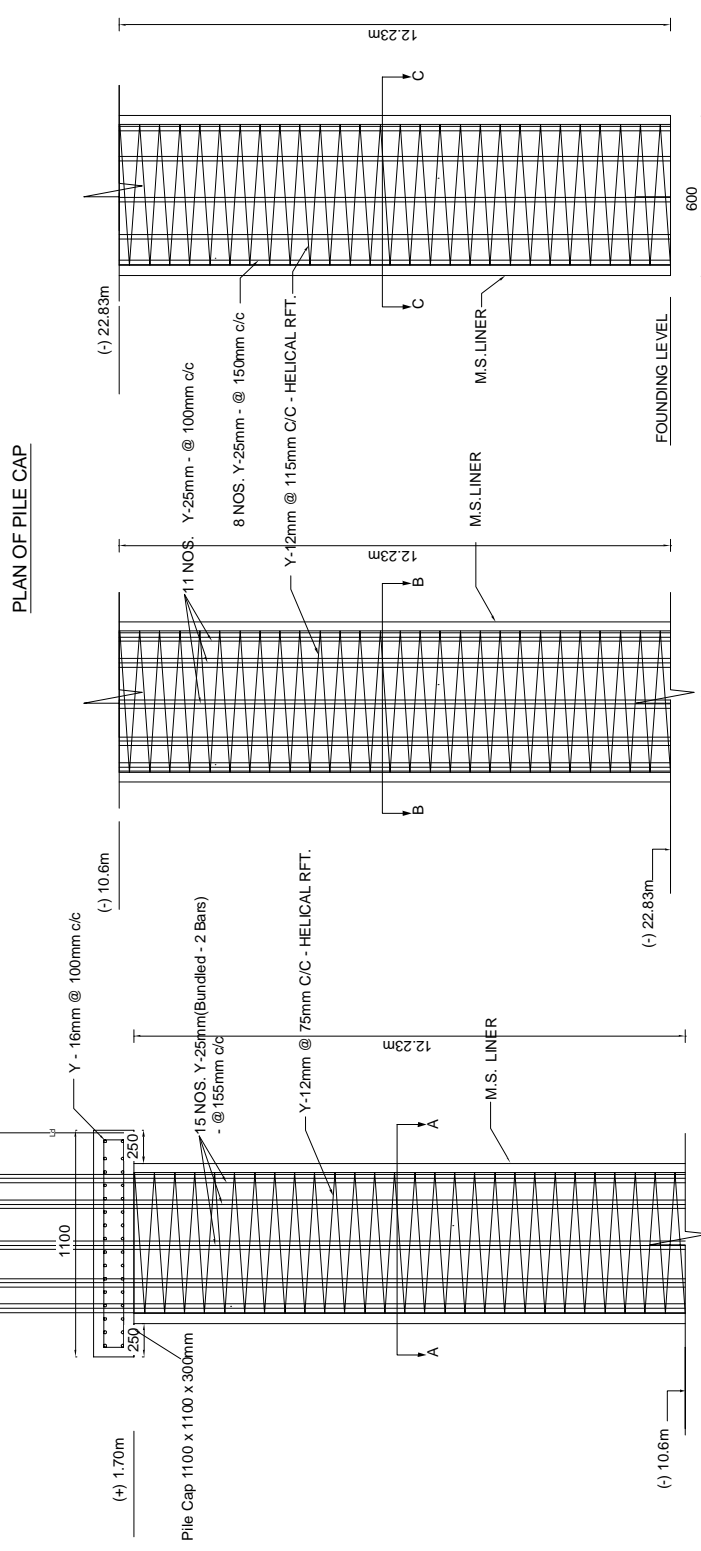
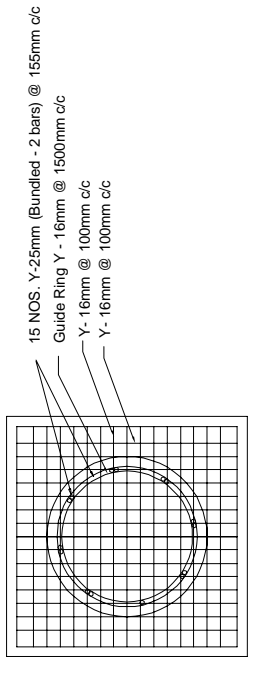
DRAWING TITLE: **DETAILS OF LONGITUDINAL BEAMS**

DRAWING NUMBER: **80614746-DWG-TD-0000-CS-2007**

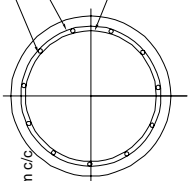
REV: **0**

NOTES:

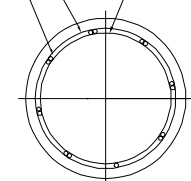
- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE CHECKED BEFORE LAYING SOIL AND LINER WORKS.
- 3 WORKS SHALL BE DONE IN ACCORDANCE WITH THE DEVELOPMENT LENGTH OF BARS SHALL BE MIN. 40 TIMES THE DIA OF BARS. ONLY 50% OF THE BARS SHALL BE STAGGERED AT A DISTANCE OF MINIMUM 1.30 TIMES LA PART.



SECTION A-A



SECTION B-B



SECTION C-C

ISSUED FOR TENDER

REV.	DATE	DESCRIPTION	DRG. NO.	APP.
REVISION DETAILS				
OWNER: COCHIN PORT TRUST				
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOOCH				
PARTICULARS ARE:				
DIMENSIONS ARE IN:				
PURPOSE:				
DRAWING TITLE: REINFORCEMENT DETAILS OF PILE				
DRAWING NUMBER: 80014746-DWG-TD-0000-CS-2008				
REV.	0			



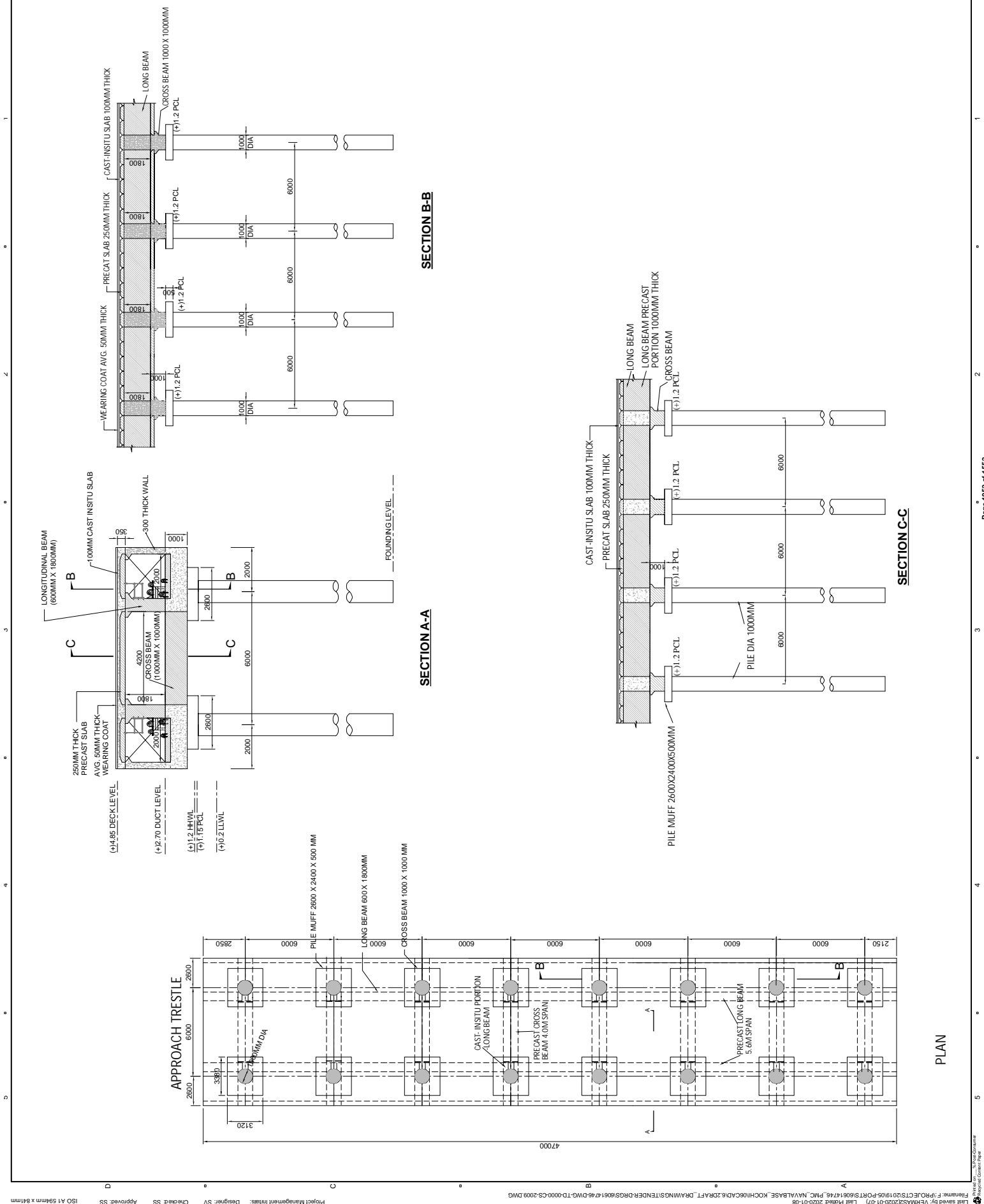
AECOM India Pvt. Ltd.

NOTES:
 1 ALL DIMENSIONS ARE MILLIMETER AND LEVELS ARE IN METER WITH RESPECT TO CHART DATUM

ISSUED FOR TENDER

REV	DATE	REVISION	DR	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE:					
PURPOSE:					
DRAWING TITLE: APPROACH TRESTLE PLAN AND CROSS SECTION					
DRAWING NUMBER: 80814746-DWG-TD-0000-CS-2009					
REV: 0					

AECOM
 AECOM India Pvt. Ltd.



NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.
- 3 UNLESS OTHERWISE LAPS SHALL BE MIN. 40 TIMES THE DIA OF BARS. ONLY 50% OF THE DEVELOPMENT LENGTH OF BARS SHALL BE STAGGERED AT A DISTANCE OF MINIMUM 1.30 TIMES LAP PART.

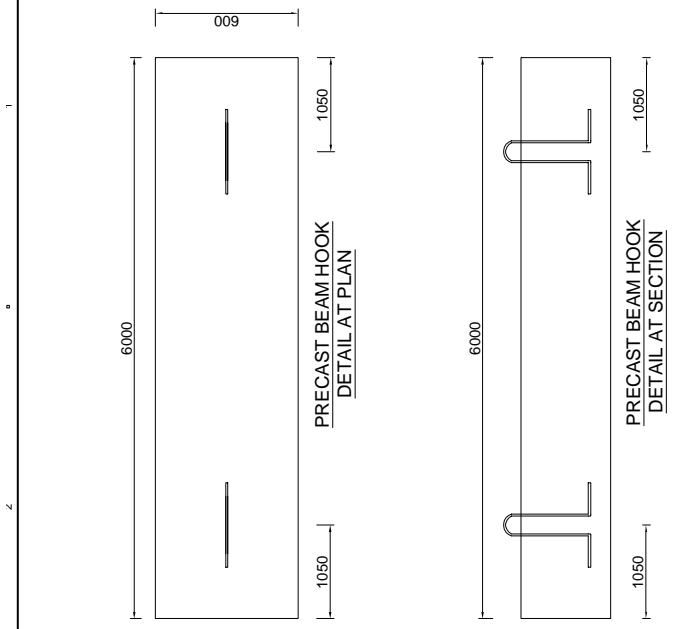
ISSUED FOR TENDER

REV.	DATE	REVISIONS	DRN	CHK	APP
		REVISION DETAILS			

OWNER: COCHIN PORT TRUST
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
PARTICULARS: DIMENSIONS ARE IN
PURPOSE:

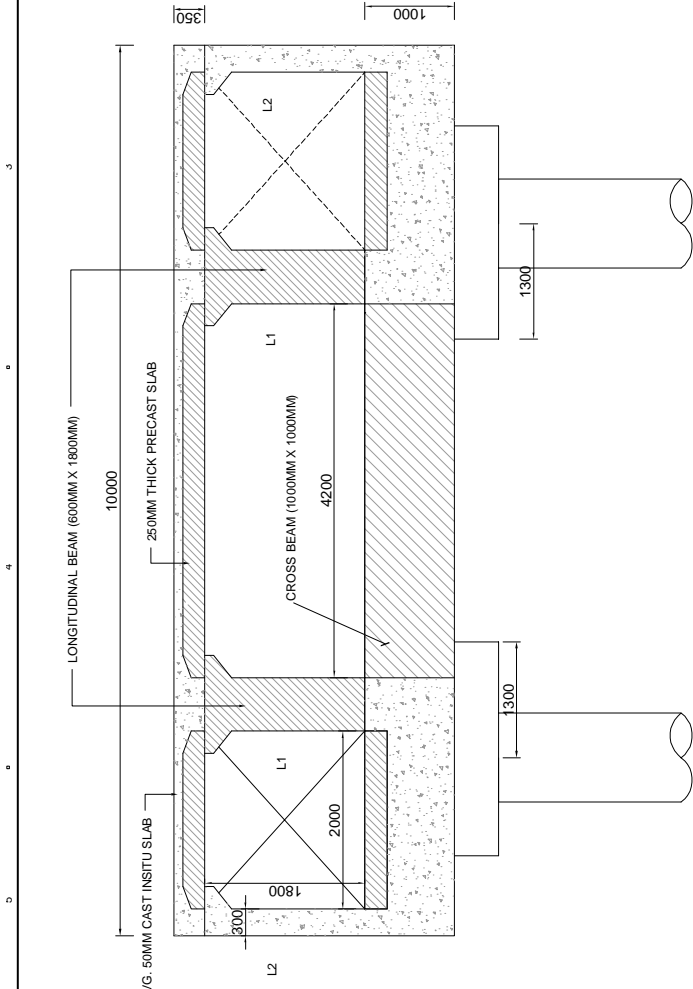
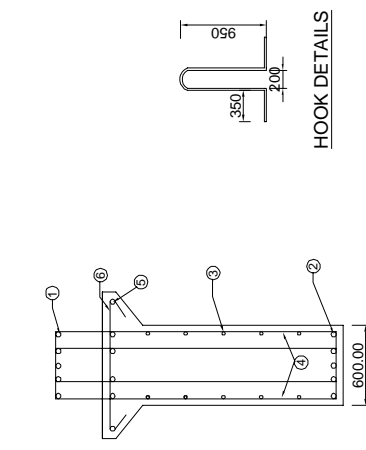
DRAWING TITLE: APPROACH TRESTLE REINFORCEMENT DETAILS OF LONGITUDINAL BEAM
DRAWING NUMBER: 80814746-DWG-TD-0000-CS-2010
REV: 0

AECOM
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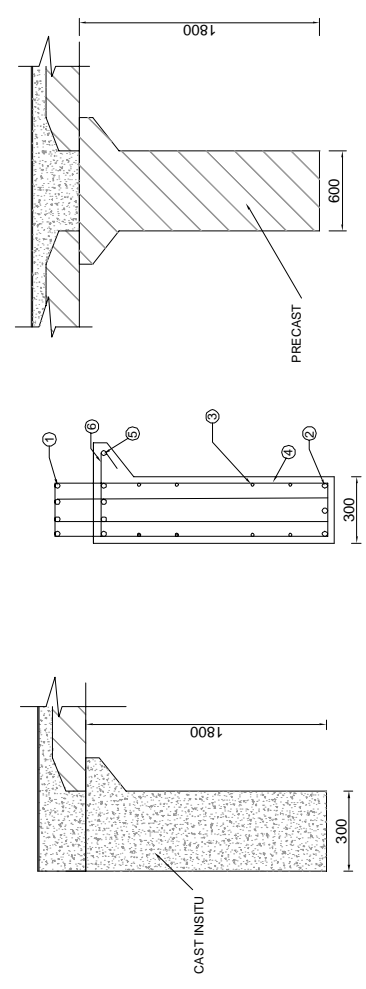
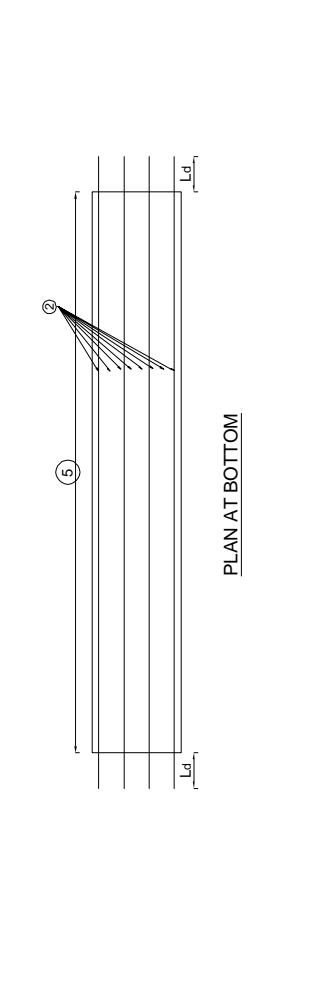


REINFORCEMENT DETAILS OF LONG BEAM

BAR MARK	TYPE AND DIAMETER		REMARKS
	Long Beam L1	Long Beam L2	
1	5 NOS. Y - 25	3 NOS. Y - 25	MAIN RFT. (TOP)
2	5 NOS. Y - 25	3 NOS. Y - 25	MAIN RFT. (BOT.)
3	4 NOS. Y - 16	4 NOS. Y - 16	SIDE FACE
4	4L - Y12 @ 50mm C/C	4L - Y12 @ 50mm C/C	STIRRUPS
5	2 NOS. Y - 25	2 NOS. Y - 25	CORBEL
6	Y12 @ 100mm C/C	Y12 @ 100mm C/C	LINKS

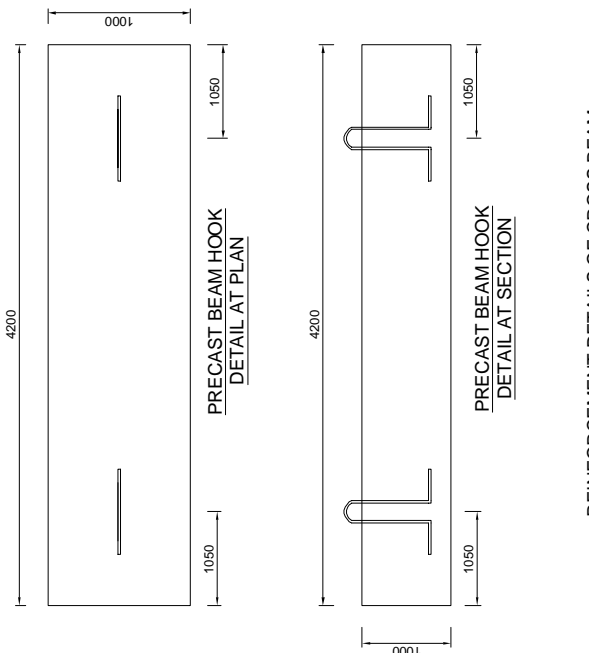


CROSS-SECTION DETAIL OF APPROACH TRESTLE



NOTES:

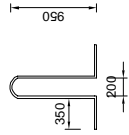
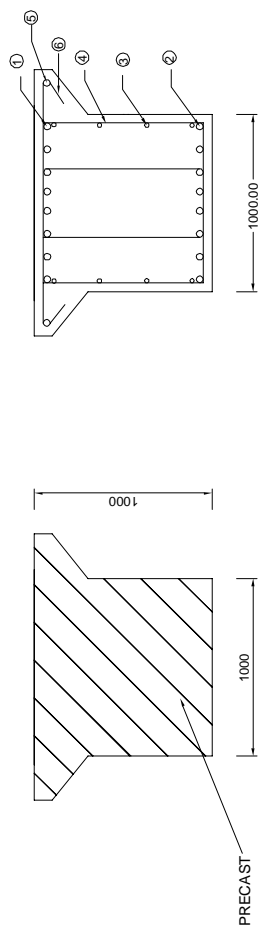
- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOLID AND LINER WORKS.
- 3 UNLESS NOTED OTHERWISE, LAP JOINTS/ DEVELOPMENT LENGTH OF BARS SHALL BE MIN. 40 TIMES THE DIA OF BARS. ONLY 50% OF THE BARS SHALL BE STAGGERED AT A DISTANCE OF MINIMUM 1.30 TIMES LAP PART.



REINFORCEMENT DETAILS OF CROSS BEAM

BAR MARK	TYPE AND DIAMETER	REMARKS
1	8 NOS. Y - 32	MAIN RFT. (TOP)
2	8 NOS. Y - 32	MAIN RFT. (BOT.)
3	4 NOS. Y - 16	SIDE FACE
4	4L - Y12 @ 50mm CC	STIRRUPS
5	2 NOS. Y - 25	CORBEL
6	Y12 @ 100mm CC	LINKS

PLAN AT BOTTOM



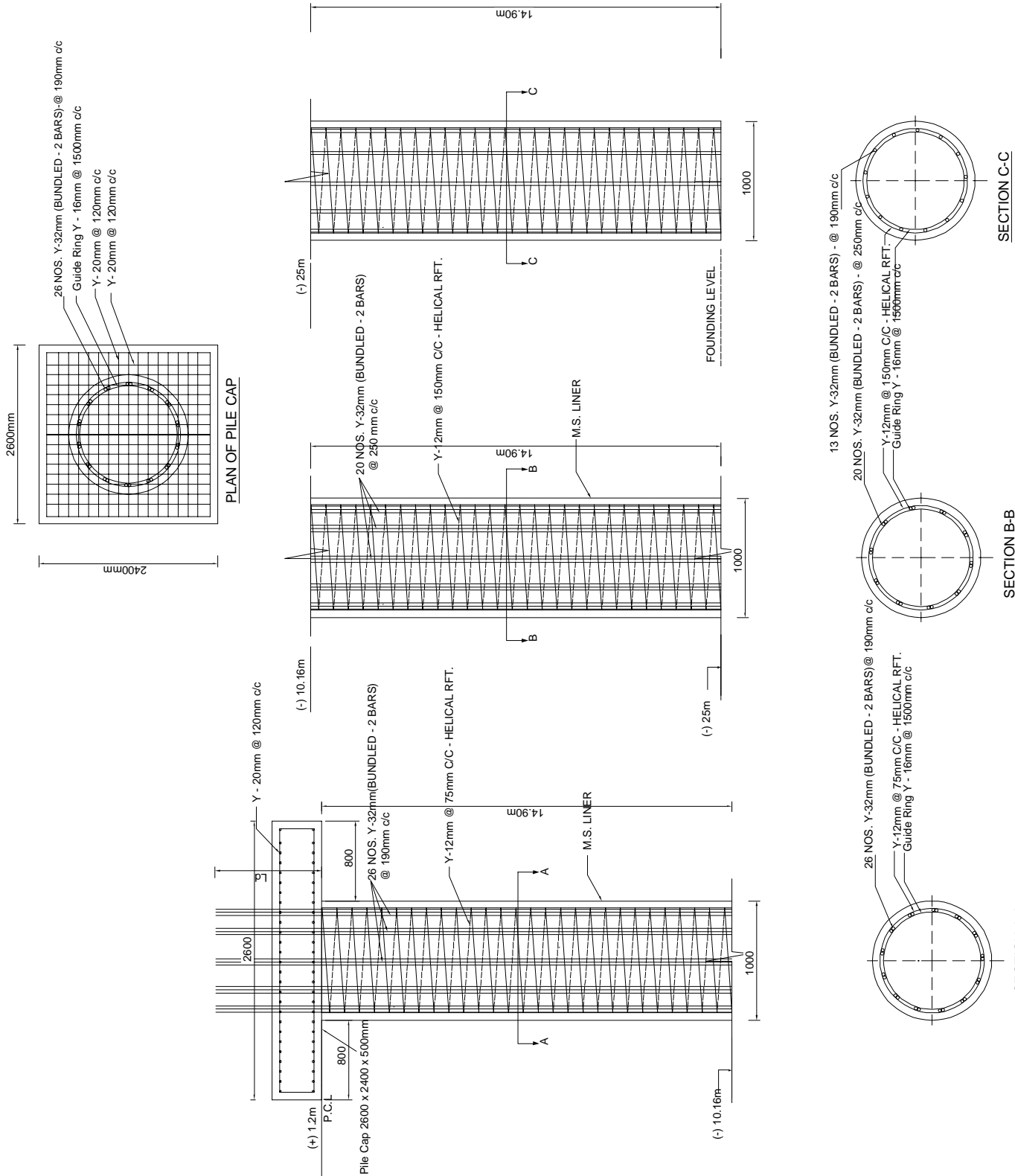
ISSUED FOR TENDER

REV	DATE	REVISION	DR	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE:					
DRAWING TITLE: APPROACH TRESTLE REINFORCEMENT DETAILS OF CROSS BEAM					
DRAWING NUMBER: 80014746-DWG-TD-0000-CS-2011					
REV: 0					



NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS (m) AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.
- 3 UNLESS NOTED OTHERWISE, LAP JOINTS IN DEVELOPMENT LENGTH OF BARS SHALL BE MIN. 40 TIMES THE DIA OF BARS. ONLY 50% OF BARS SHALL BE STAGGERED AT A DISTANCE OF MINIMUM 1.30 TIMES LAP PART.



ISSUED FOR TENDER

REV	DATE	REVISION	DRN	CHK	APP

REVISION DETAILS

OWNER: COCHIN PORT TRUST

PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI

PARTICULARS: DIMENSIONS ARE IN METERS

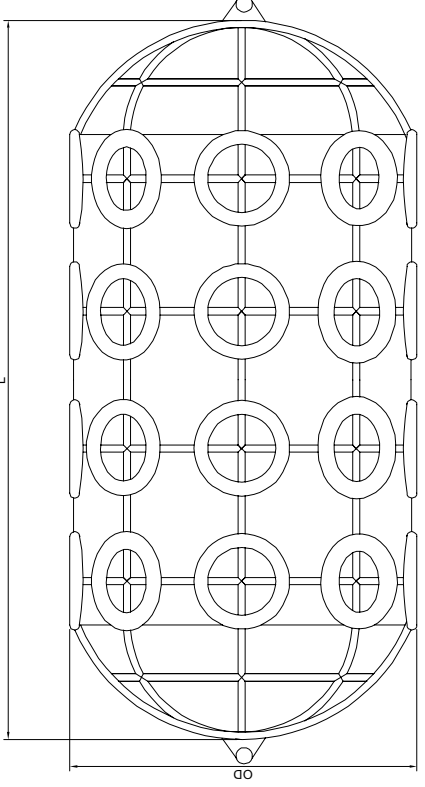
PURPOSE: APPROACH TRESTLE REINFORCEMENT DETAILS OF PILES

DRAWING TITLE: APPROACH TRESTLE REINFORCEMENT DETAILS OF PILES

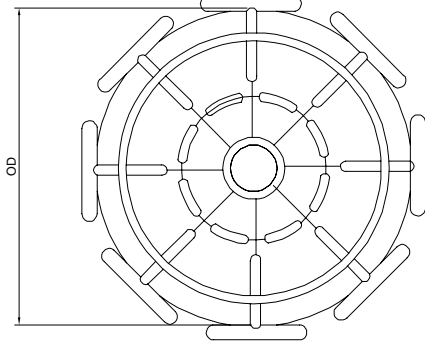
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REV:	0

SHEET 01 OF 01

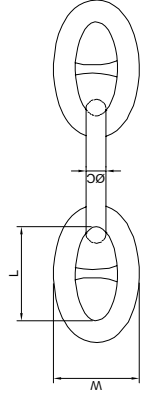
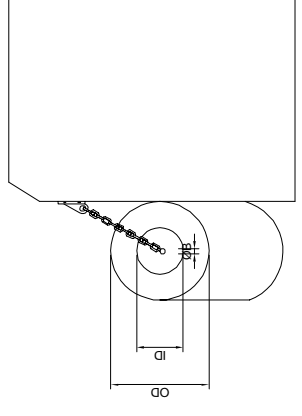




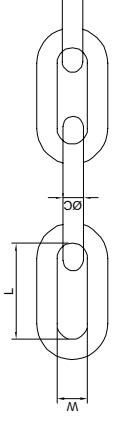
PNEUMATIC RUBBER FENDER



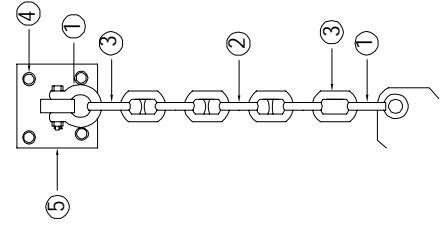
CYLINDRICAL FENDER



STUD LINK CHAINS



OPEN LINK CHAINS



1. Bolt Type anchor Shackle
2. Stud Link or Open Link chain
3. End Links are Chain with Stud removed
4. Anchor Bolt
5. Chain Bracket

CHAINS

ISSUED FOR TENDER

REV	DATE	REVISION	DR	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE IN DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE:					
TYPICAL DETAILS OF FENDERS					
DRAWING NUMBER:	80014746-DWG - TD - 0000 - CS-2013				
REV:	0				

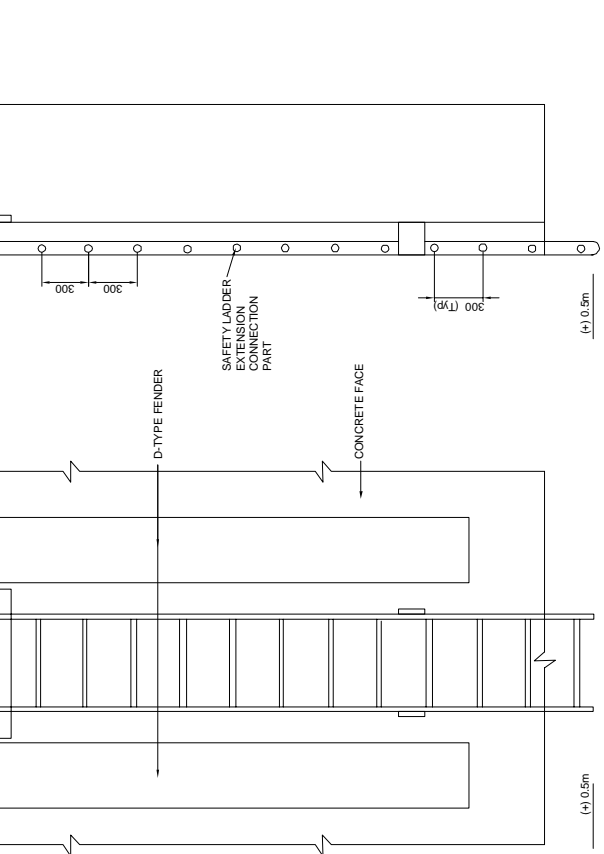
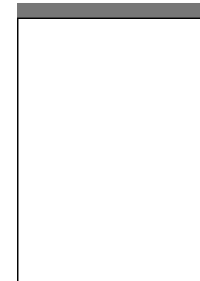


[Units: mm, kg/m, kN]

REV	DATE	REVISION	DR	CHK	APP
		REVISION DETAILS			

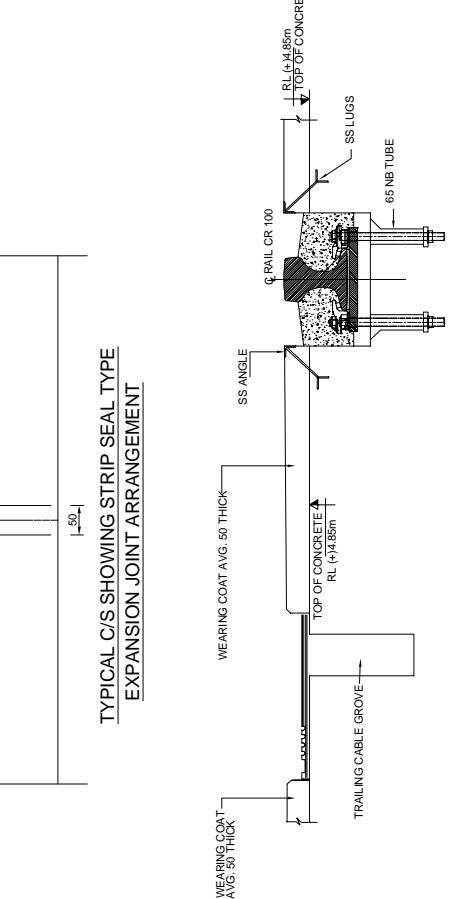
ISSUED FOR TENDER

OWNER: **COCHIN PORT TRUST**
 PROJECT: **PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI**
 PARTICIPANTS: **PM**
 DRAWING TITLE: **TYPICAL DETAILS OF BOLLARDS, CRANE FIXTURES AND LADDER**
 DRAWING NUMBER: **80814746-DWG-TD-0000-CS-2014**
 SHEET: **01 OF 01**
 REV: **0**



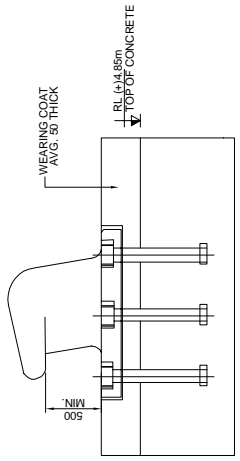
SIDE VIEW OF LADDER

ELEVATION OF LADDER

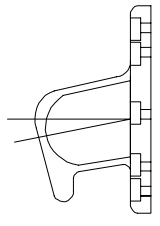


TYPICAL C/S SHOWING STRIP SEAL TYPE EXPANSION JOINT ARRANGEMENT

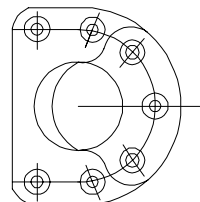
TYP. DETAILS OF RAIL BOLT FIXTURES IN CRANE BEAM
SCALE: NTS



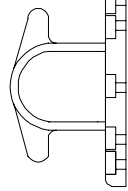
ELEVATION OF TEE BOLLARD



SECTION OF TEE BOLLARD



PLAN OF TEE BOLLARD



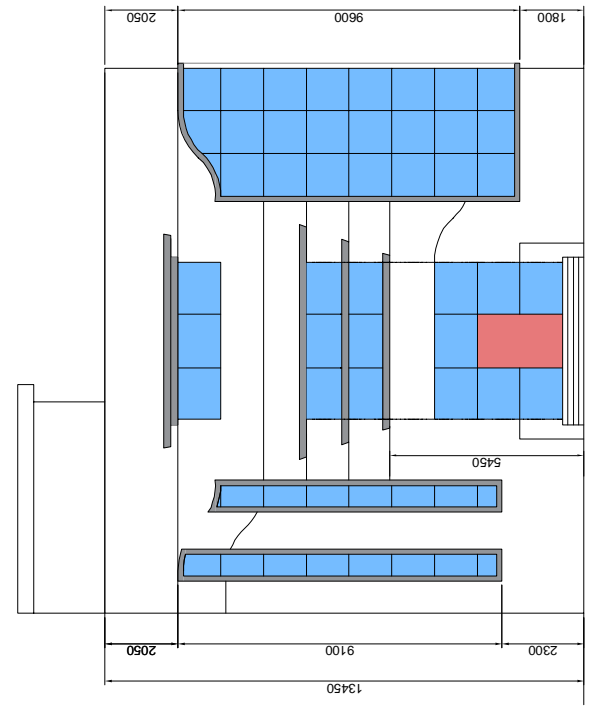
SECTION OF TEE BOLLARD

NOTES:
 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.

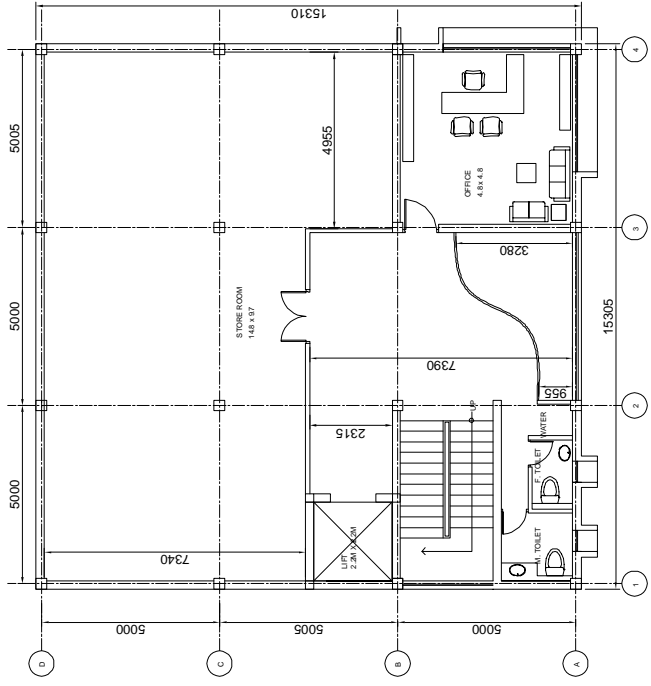
ISSUED FOR TENDER

REV	DATE	DESCRIPTION	BY	CHECKED	APP.
		REVISION DETAILS			
OWNER: COCHIN PORT TRUST PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI PARTICULARS: DIMENSIONS ARE IN PURPOSE:					
DRAWING TITLE: OFFICE CUM STORE BUILDING (GROUND FLOOR + 2) DRAWING NUMBER: 80014746-DWG-TD-0000-PL-3003 REV: 0					

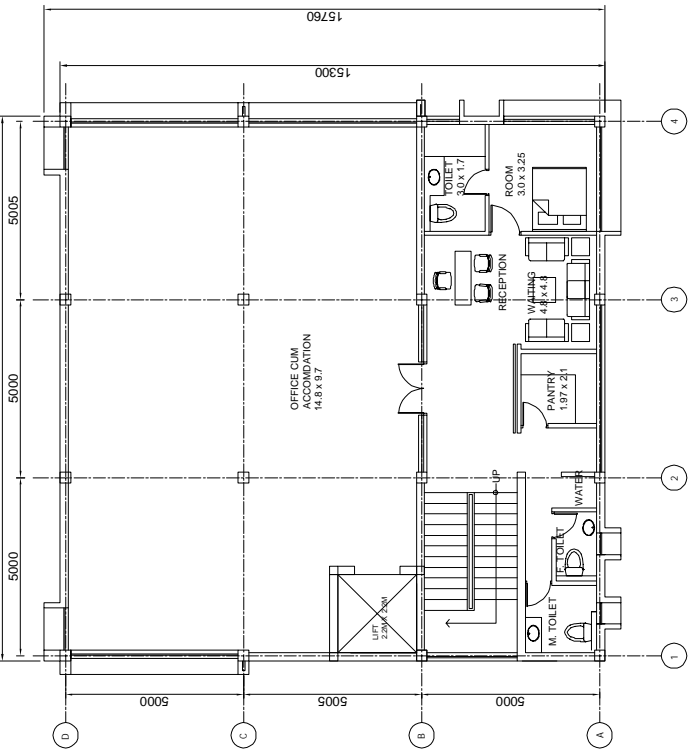
AECOM
 AECOM India Pvt. Ltd.



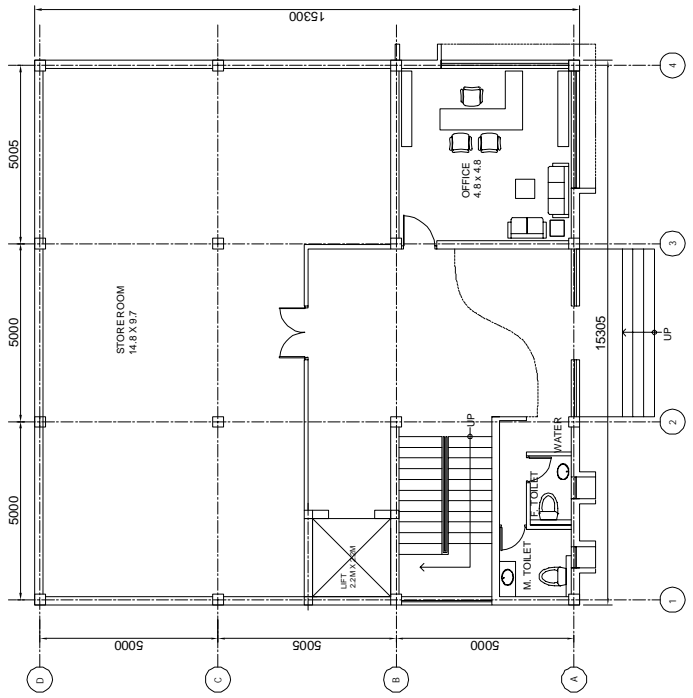
FRONT ELEVATION



FIRST FLOOR PLAN



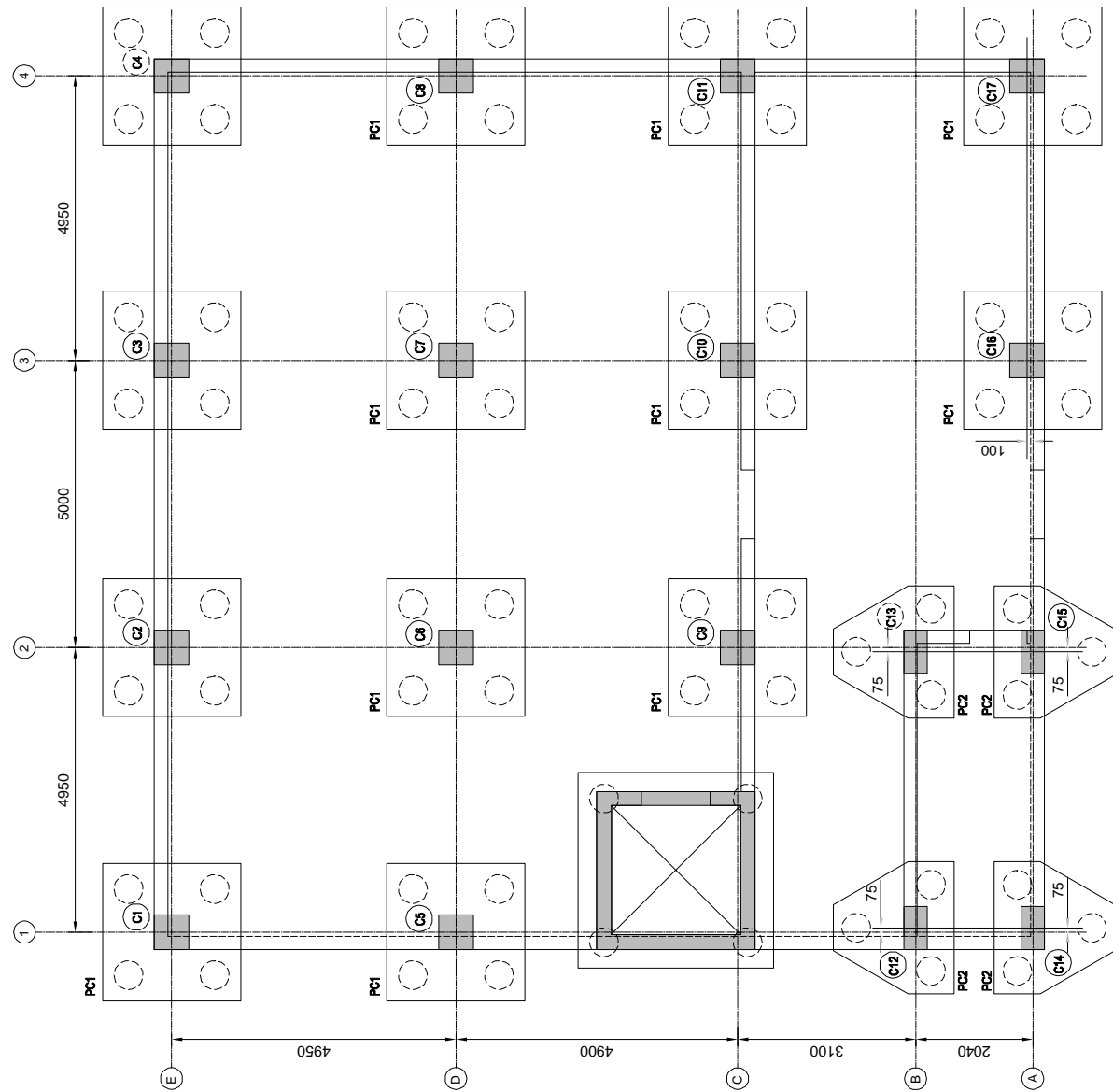
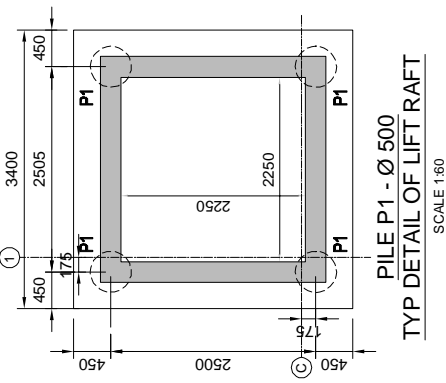
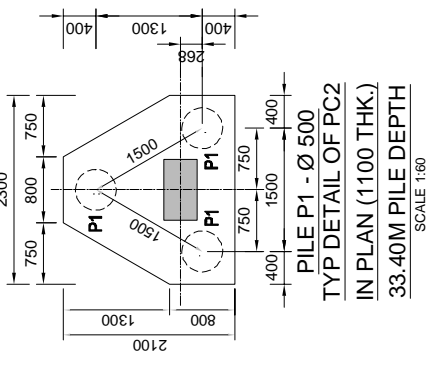
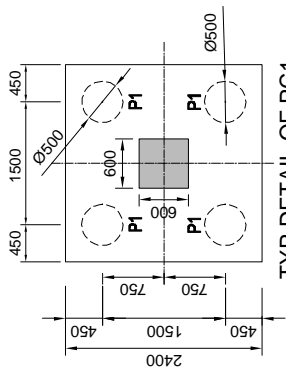
SECOND FLOOR PLAN



GROUND FLOOR PLAN

NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS (M) AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.
- 3 UNLESS NOTED OTHERWISE LAP LENGTH OF BARS SHALL BE 48D (D=DIAMETER) AND MIN. 40 TIMES THE DIA OF BARS. ONLY 90% OF BARS SHALL BE LAPED AT A SECTION. LAPS SHALL BE AT A MINIMUM SURFACE OF MINIMUM 1.30 TIMES LAP PART.



ISSUED FOR TENDER

REV	DATE	DESCRIPTION	DRN	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS: DIMENSIONS AREA					
PURPOSE: OFFICE CUM STORE BUILDING PILE LAYOUT					
DRAWING TITLE: OFFICE CUM STORE BUILDING PILE LAYOUT					
DRAWING NUMBER: 80614746-DWG-TD-0000-PL-3004					
SHEET: 01 OF 01					
REV	0				



NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS (M) AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.
- 3 UNLESS NOTED OTHERWISE LAP LENGTH OF BARS SHALL BE 40 TIMES THE DIAMETER. LAP JOINTS SHALL BE STAGGERED AT LEAST 1.30 TIMES LAP PART.

REV	DATE	REVISIONS/DETAILS	DR	CHK	APP

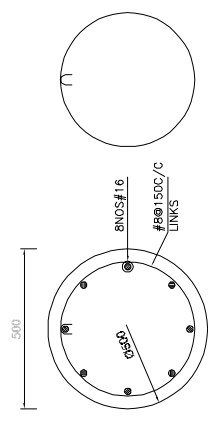
ISSUED FOR TENDER

OWNER: COCHIN PORT TRUST
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
PARTICULARS: DIMENSIONS ARE IN METERS
PURPOSE:

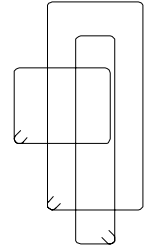
DRAWING NUMBER: 80614746-DWG-TD-0000-PL-3005
REV: 0

DRAWING TITLE: OFFICE CUM STORE BUILDING DETAILS OF PILECAPS

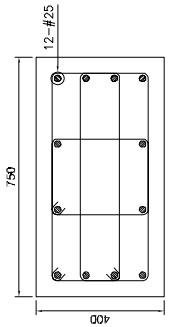
AECOM
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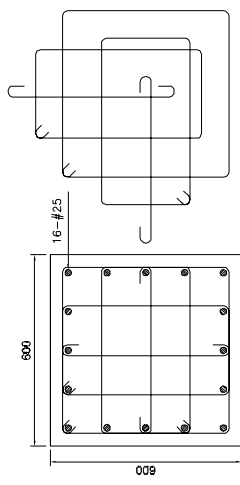
DETAIL OF LINK
SCALE 1:12



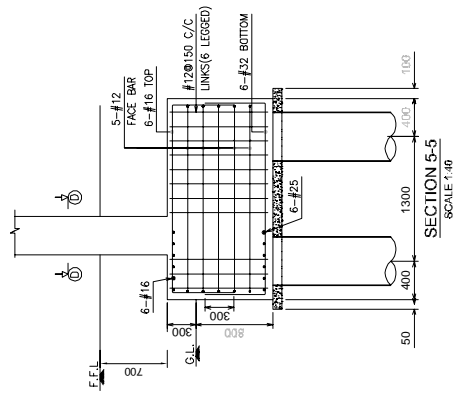
DETAIL OF LINK
SCALE 1:12



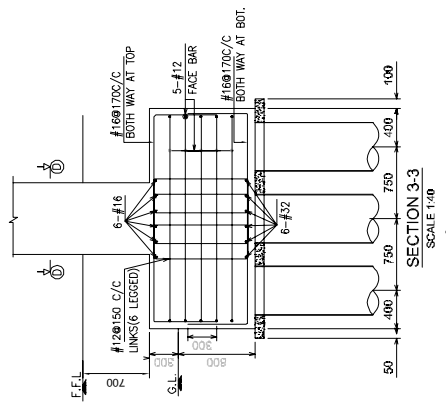
SECTION D-D
SCALE 1:12



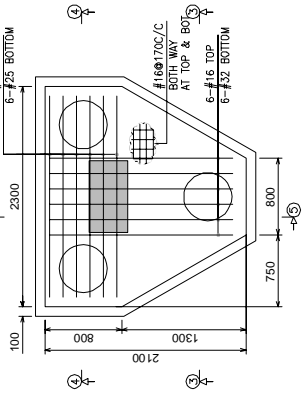
DETAIL OF LINK
SCALE 1:12



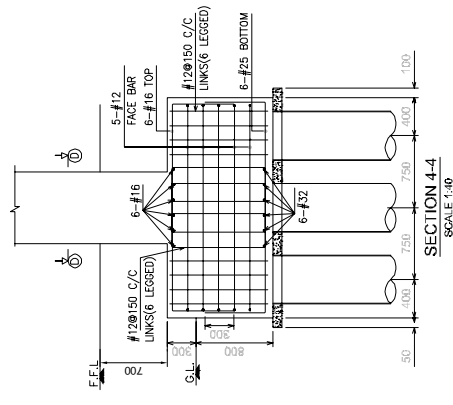
SECTION 5-5
SCALE 1:40



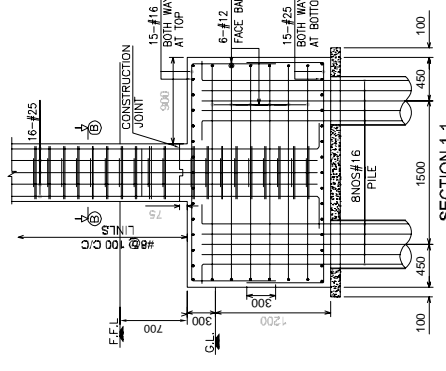
SECTION 3-3
SCALE 1:40



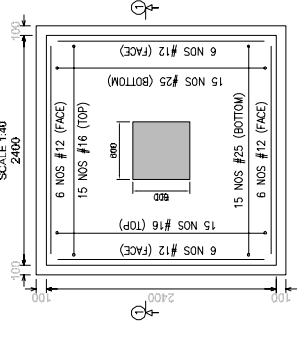
DETAIL PLAN FOR PILE CAP - PC2
SCALE 1:40



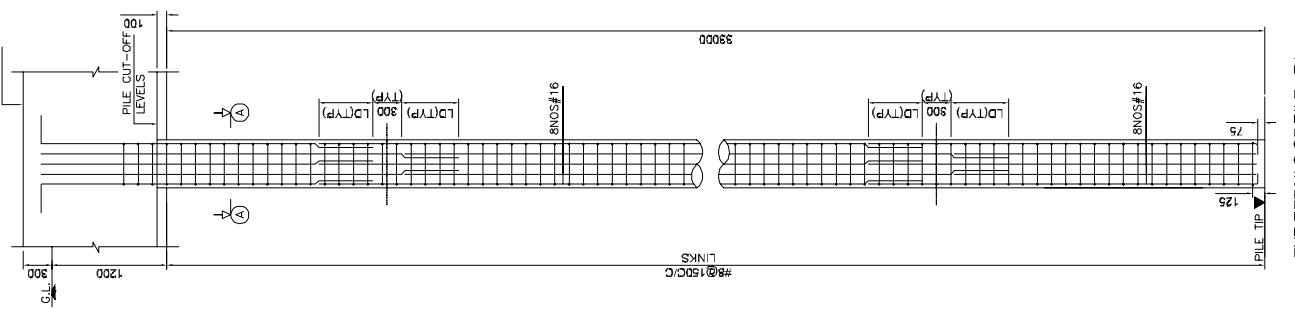
SECTION 4-4
SCALE 1:40



SECTION 1-1
SCALE 1:40



DETAIL PLAN FOR PILE CAP - PC1
SCALE 1:40

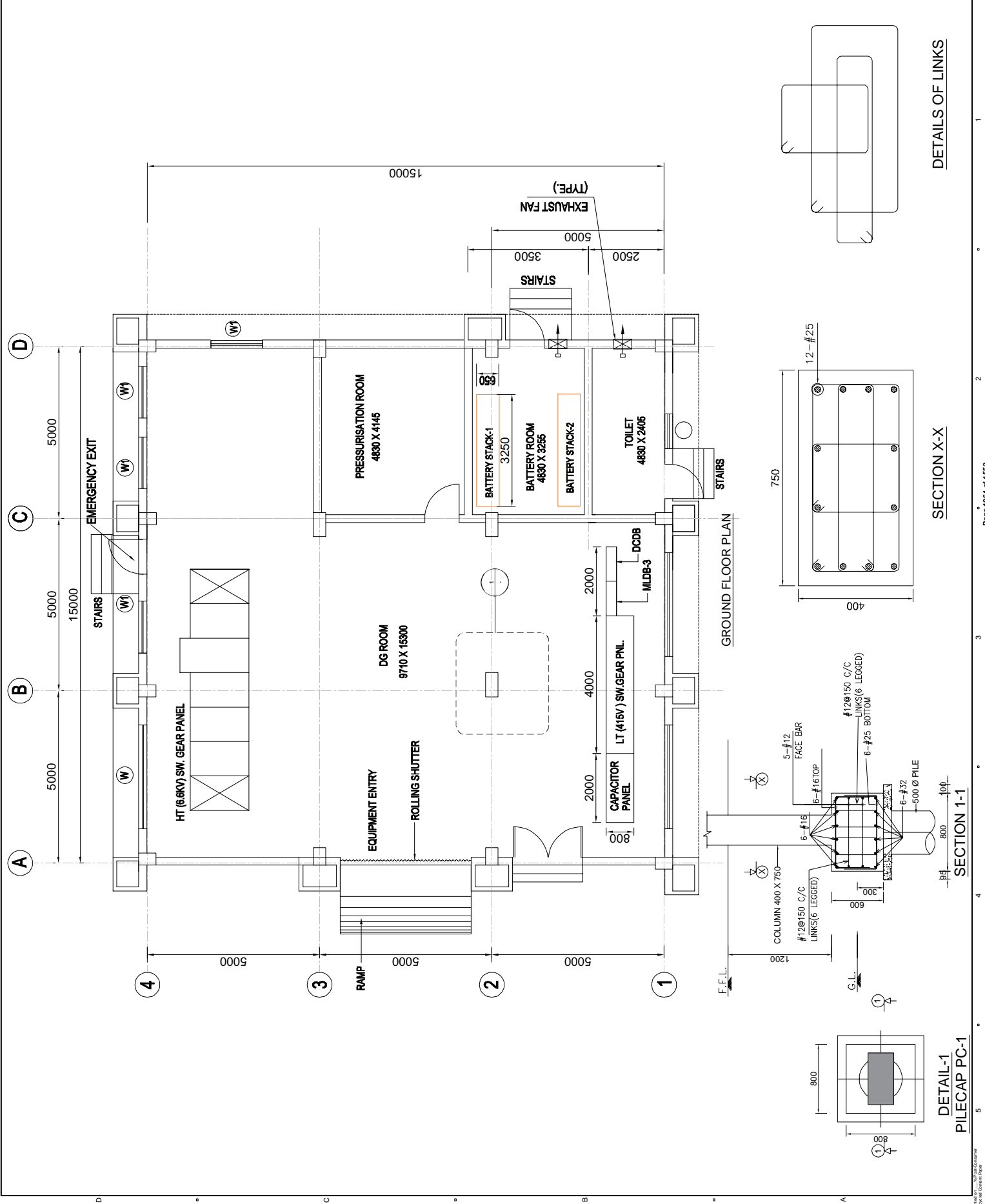


TYP DETAILS OF PILE - P1
SCALE 1:10

- NOTES:**
- 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
 - 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.
 - 3 DIMENSIONS OF 600kVA DG SET, BATTERY CHARGER, TRANSFORMER, 600kVA, 600/433kV TRANSFORMER, AMP PANEL etc. TO BE CHECKED WITH THE MANUFACTURER'S DRAWINGS.

ISSUED FOR TENDER

NO.	DATE	REVISION	BY	CHKD	APPD
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS: DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE: D.G. ROOM DETAILS AT GROUND FLOOR LEVEL					
DRAWING NUMBER: 80014746-DWG-TD-0000-PL-3006					
REV: 0					



DETAILS OF LINKS

SECTION X-X

SECTION 1-1

DETAIL-1
PILECAP PC-1

NOTES:
 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.

ISSUED FOR TENDER

REV.	DATE	REVISION	DRN	CHK	APP

COCHIN PORT TRUST

PROJECT: **PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI**

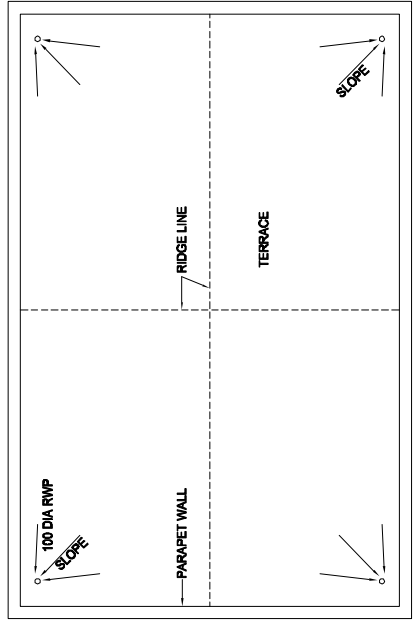
PARTICULARS: **COMPRESSOR HOUSE**

DRAWING NUMBER: **80014746-DWG-TD-0000-PL-3007-0**

REVISIONS ARE IN: **0**

DRAWING TITLE: **DETAILS OF COMPRESSOR HOUSE**

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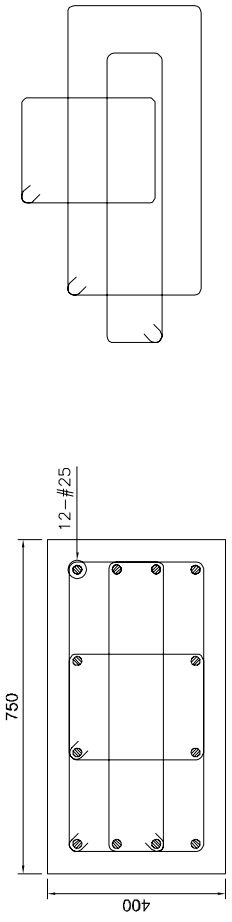
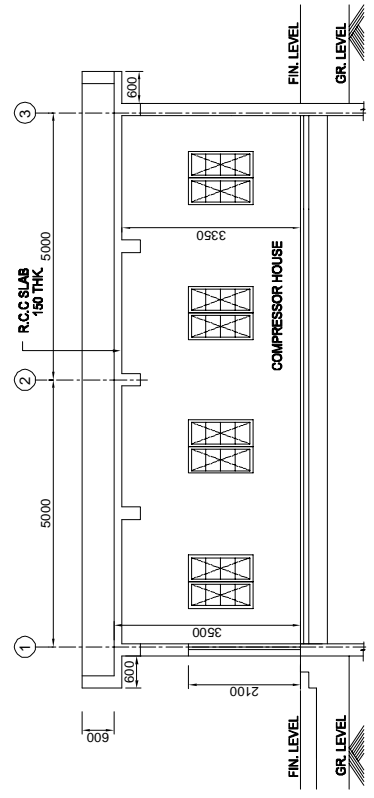


TERRACE PLAN

SCHEDULE FOR OPENINGS:

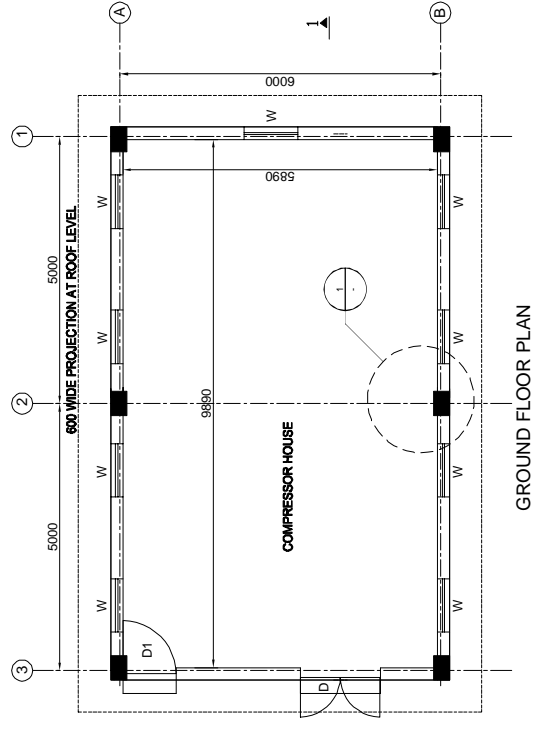
MARK	WIDTH	HEIGHT	SILL LEVEL	LINTEL LEVEL
D	1600	2100	-	2100
D1	1000	2100	-	2100
W	1000	1200	800	2100

SECTION 1-1



DETAILS OF LINKS

SECTION X-X



GROUND FLOOR PLAN

DETAIL-1
PILECAP PC-1

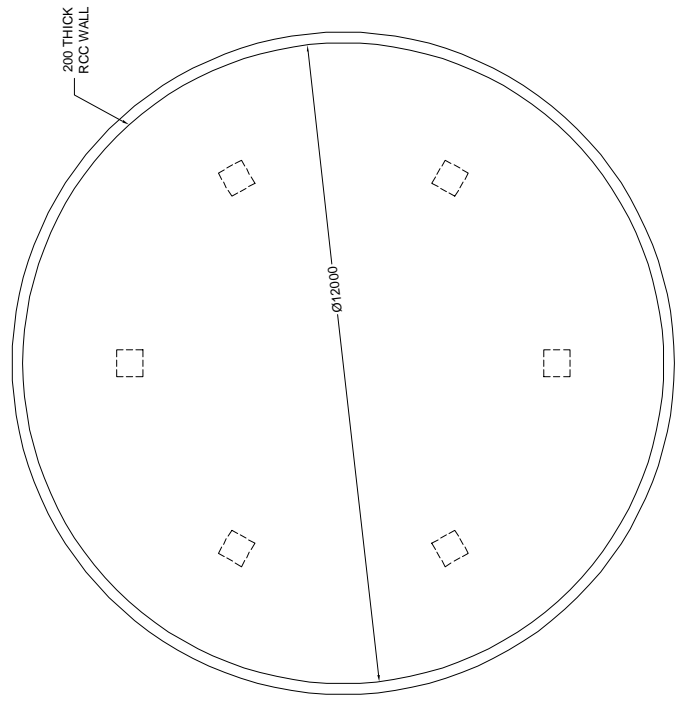
SECTION 1-1

NOTES:
 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.

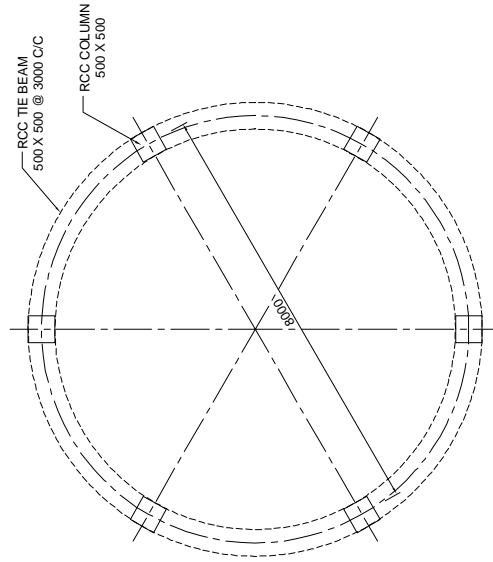
ISSUED FOR TENDER

REV	DATE	REVISION	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE IN DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE: DETAILS OF ELEVATED WATER STORAGE TANK					
DRAWING NUMBER: 80014746-DWG-TD-0000-PL-3008					
REV: 0					
SHEET 01 OF 01					

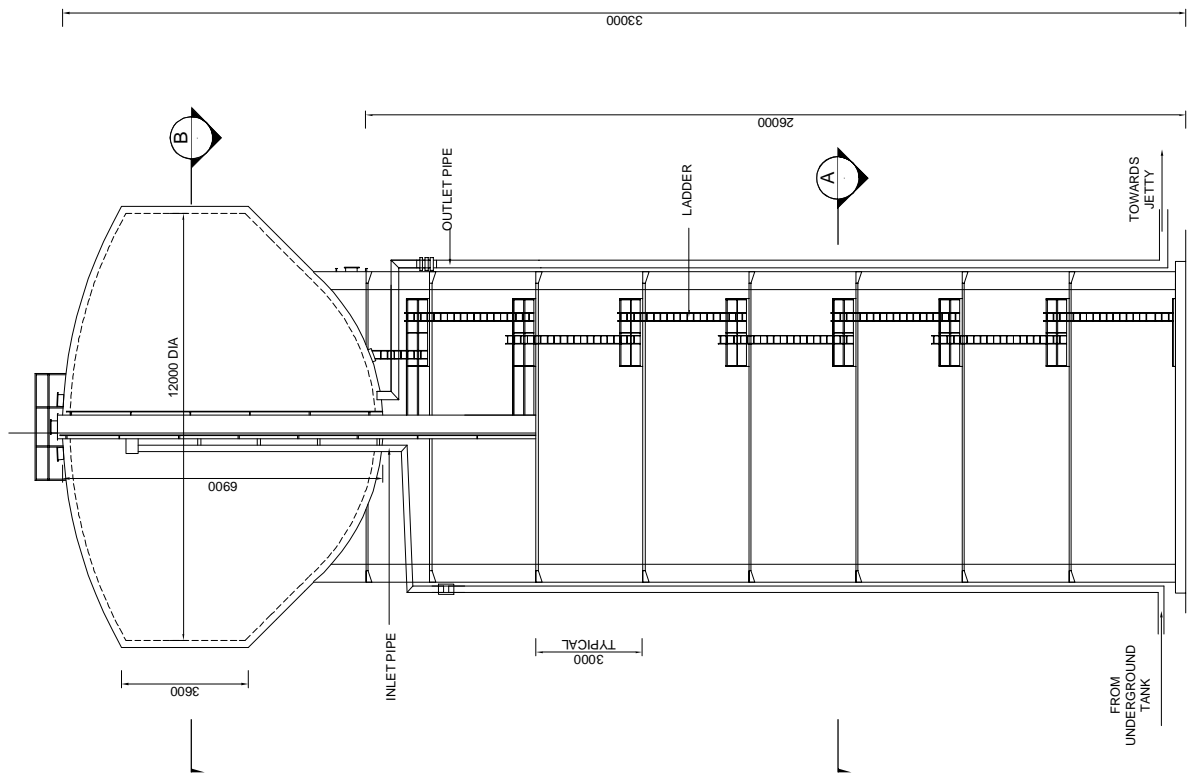
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 AECOM India Pvt. Ltd.



B SECTIONAL PLAN
 Scale 1:50



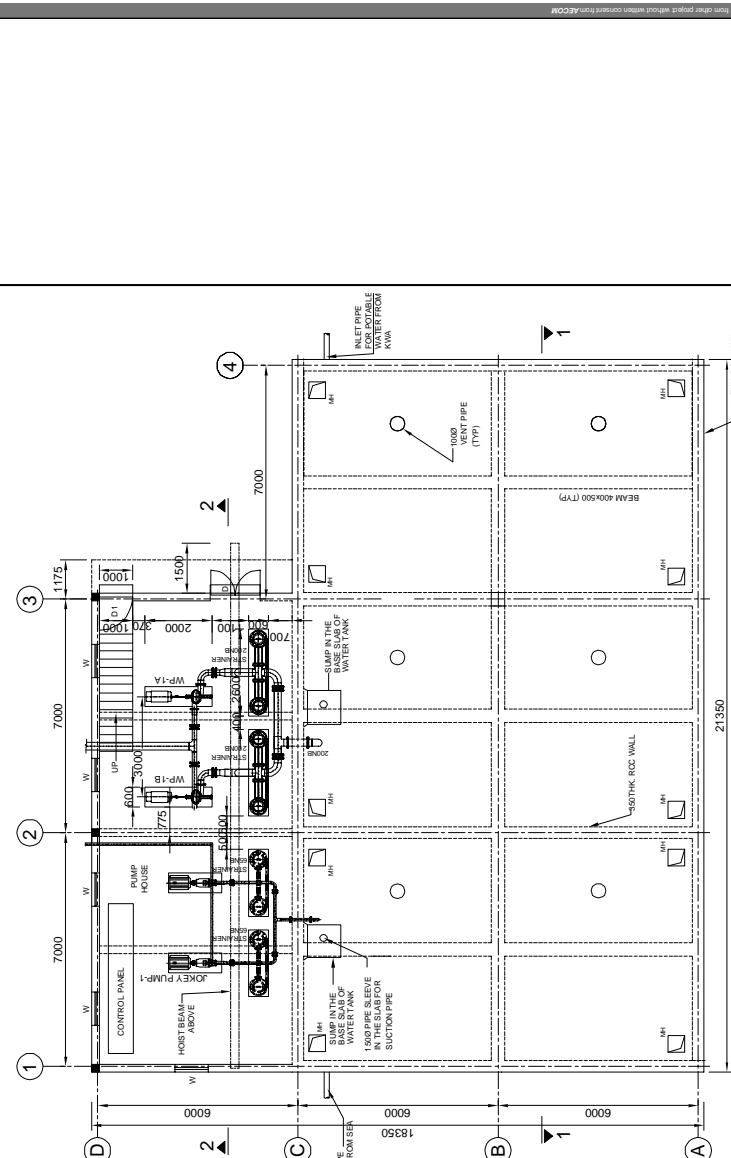
A SECTIONAL PLAN
 Scale 1:50



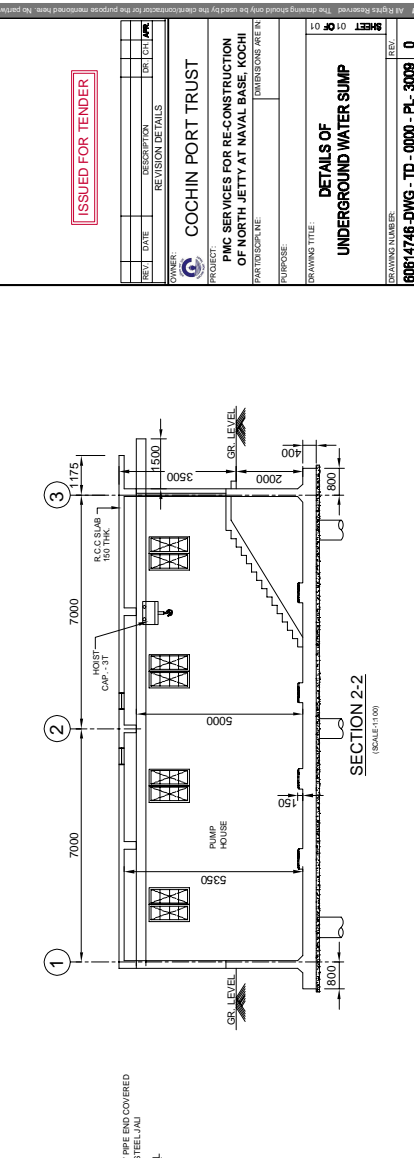
ELEVATED WATER TANK - ELEVATION
 Scale 1:75

NOTES:

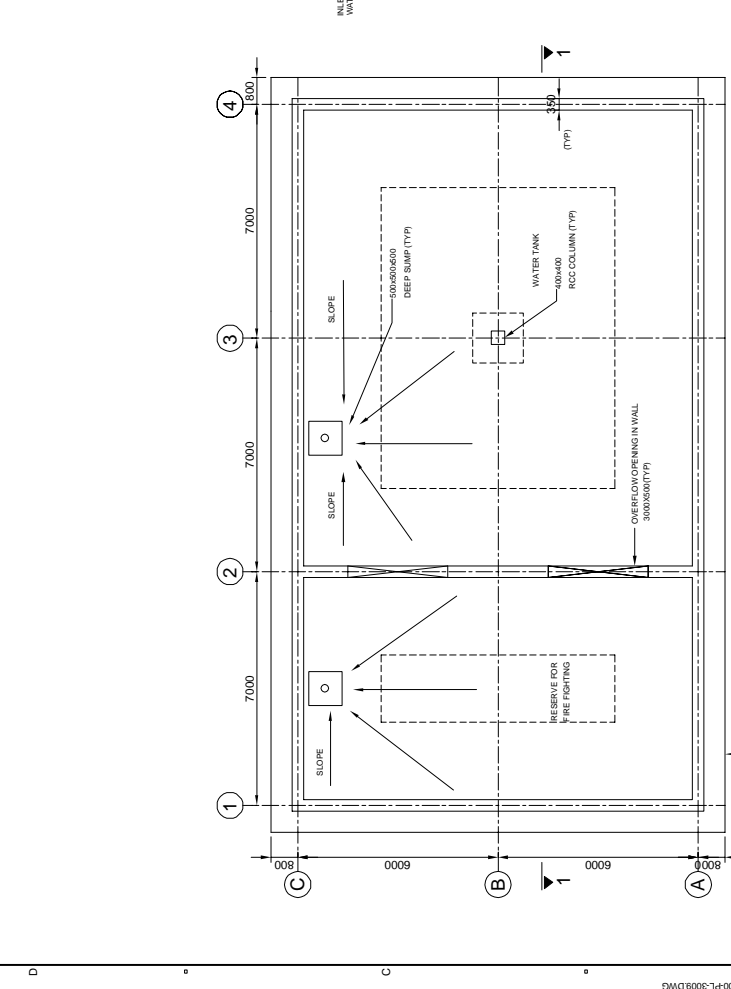
- 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.



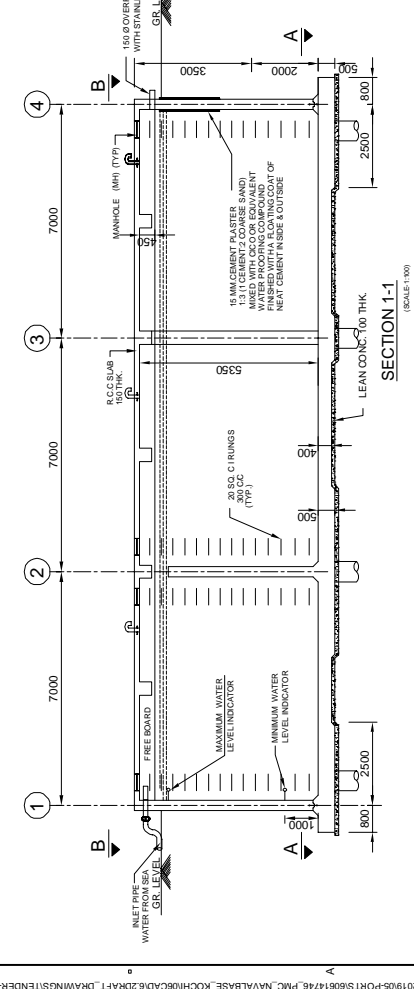
PLAN A-A
(SCALE 1:100)



SECTION 1-1
(SCALE 1:100)



PLAN B-B
(SCALE 1:100)



SECTION 2-2
(SCALE 1:100)

ISSUED FOR TENDER

REV.	DATE	REVISIONS	DR.	CHK.	APP.
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS:					
PURPOSE:					
DRAWING TITLE: DETAILS OF UNDERGROUND WATER SUMP					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-3009 0					

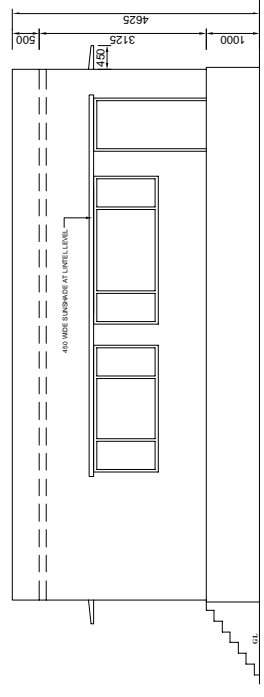
AECOM
AECOM India Pvt. Ltd.

NOTES:

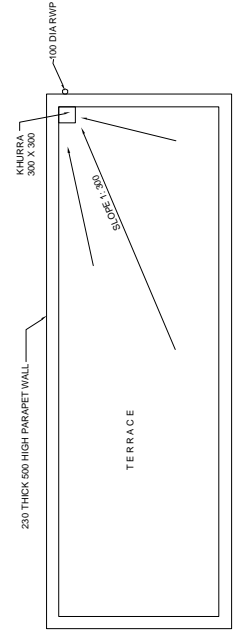
- 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.

SCHEDULE OF OPENINGS:-

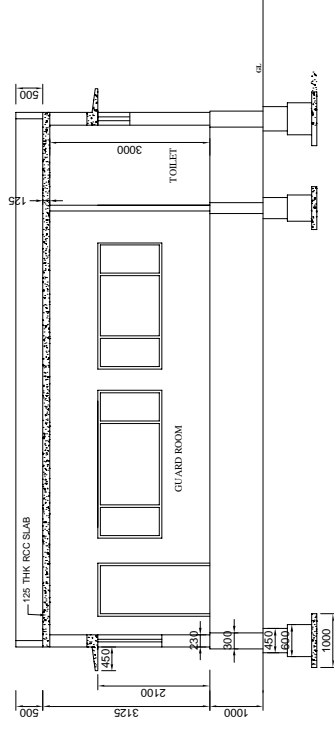
MARKED	WIDTH	HEIGHT	SILL LEVEL	UNTEL LEVEL
D1	1000	2100	-	2100
D2	750	2100	-	2100
W1	600	1500	1500	2100
W2	1500	1200	900	2100
W3	2700	1200	900	2100
W4	2300	1200	900	2100



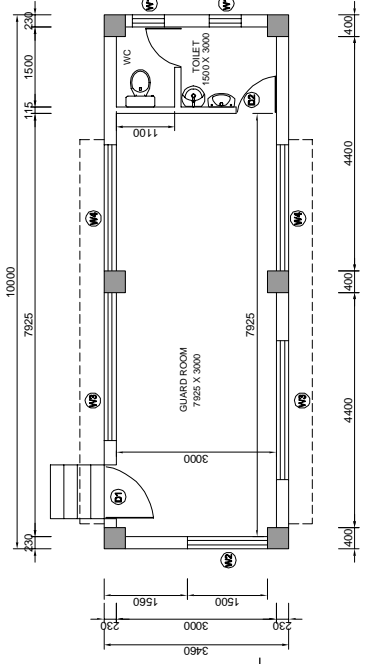
ELEVATION
Scale 1:50



TERRACE PLAN
Scale 1:50



SECTION 1-1
Scale 1:50



GROUND FLOOR PLAN
Scale 1:50

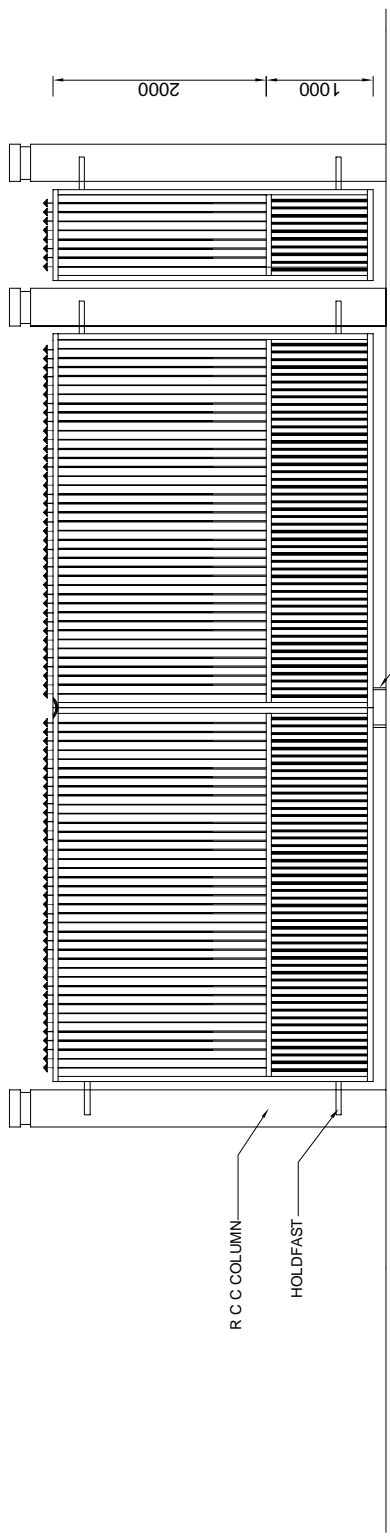
ISSUED FOR TENDER

REV	DATE	REVISION	DRG	CHK	APP
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS: PART					
DRAWING TITLE: DETAILS OF GUARD ROOM					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-3010					
REVISION NUMBER: 0					

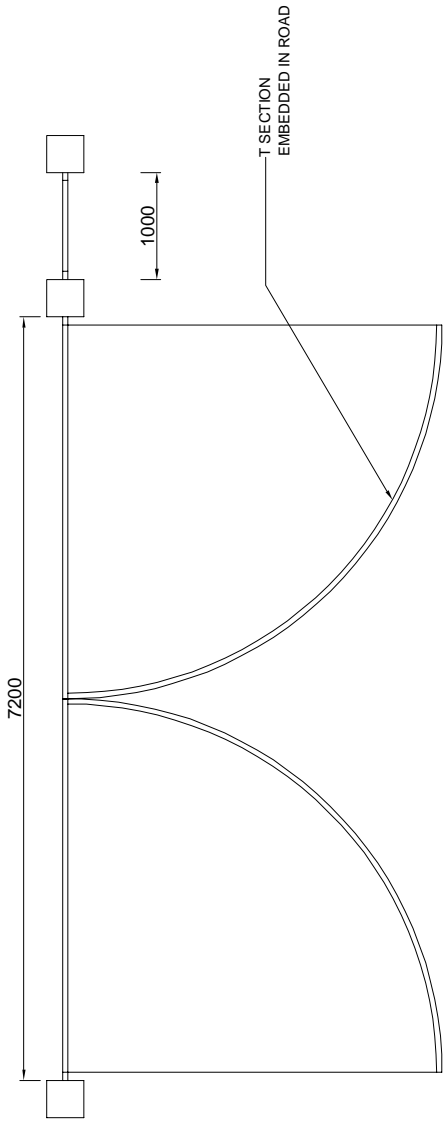
AECOM
AECOM India Pvt. Ltd.

NOTES:

- 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.
- 3 PILE FOUNDATION SHALL BE USED



ENTRY GATE - ELEVATION



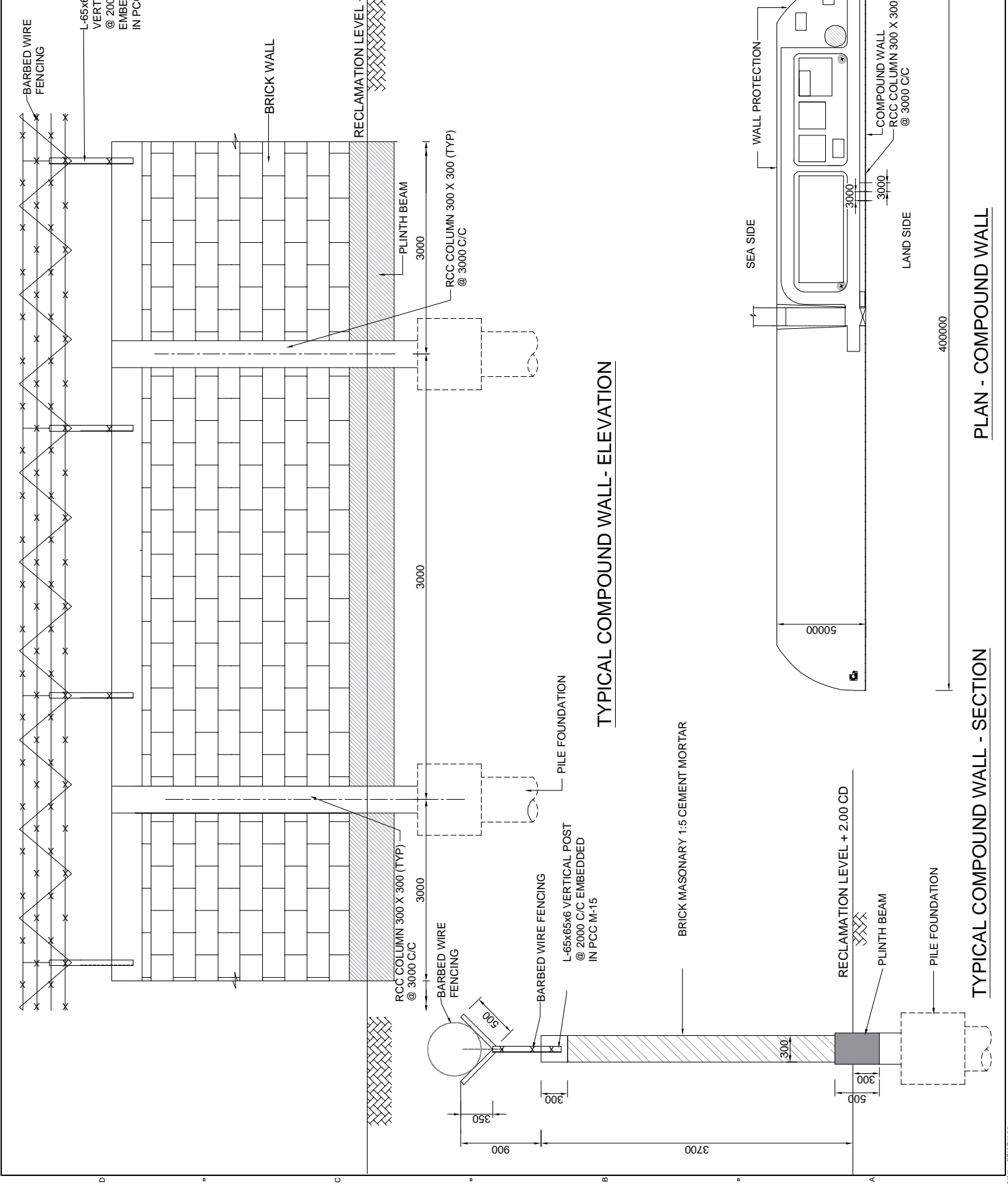
ENTRY GATE - PLAN

ISSUED FOR TENDER

REV.	DATE	REVISION	BY	CHK.	APP.
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE:					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-3011					
DRAWING TITLE: TYPICAL DETAILS OF ENTRY GATE					
SHEET 01 OF 01					
REV.	NO.				
0	0				



NOTES:
 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.



NOTES:
 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.

ISSUED FOR TENDER

REV.	DATE	DESCRIPTION	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS: DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE:					
TYPICAL DETAILS OF HIGH MAST (30 M HIGH)					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-3013					
REV: 0					

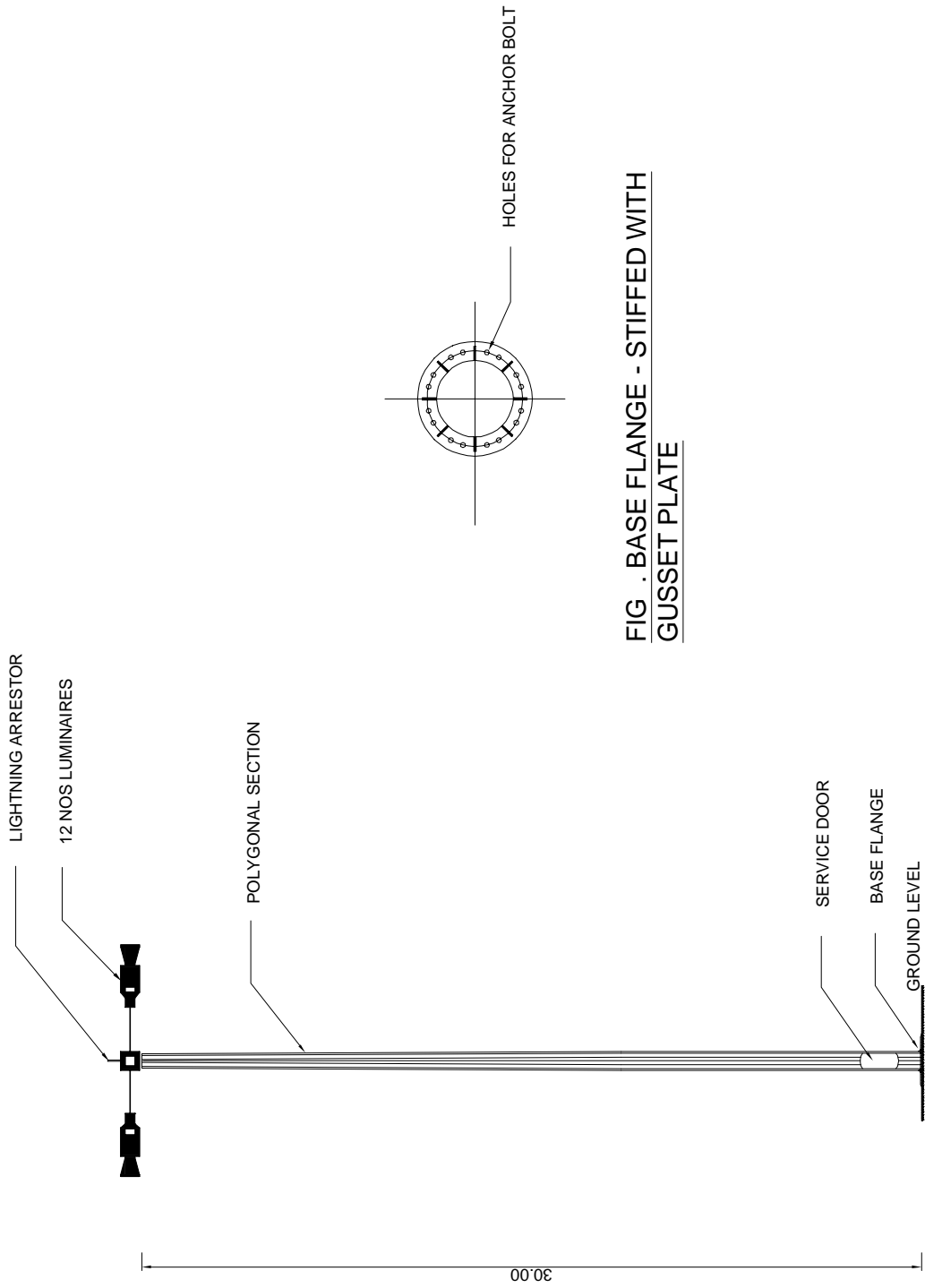
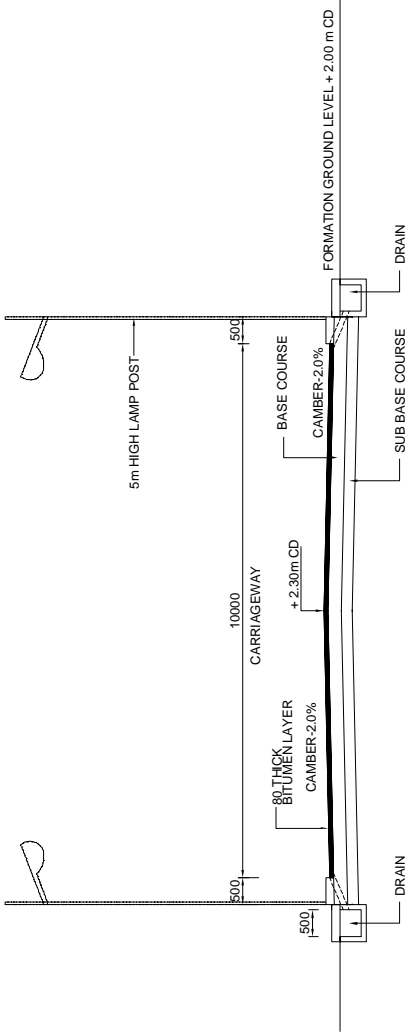


FIG . BASE FLANGE - STIFFED WITH GUSSET PLATE

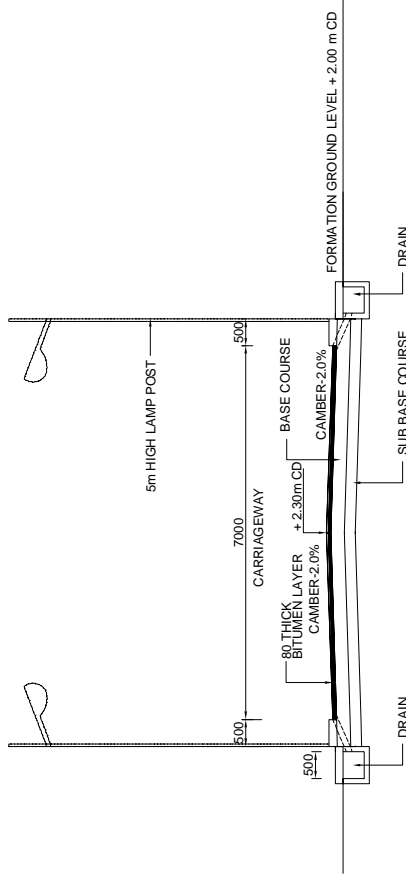
FIG . TYPICAL HIGH MAST - 30 M

NOTES:

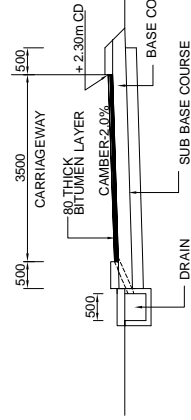
- 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
- 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.



TYPICAL CROSS SECTION OF 10M WIDE ROAD ON RECLAIMED LAND



TYPICAL CROSS SECTION OF 7M WIDE ROAD ON RECLAIMED LAND



TYPICAL CROSS SECTION OF 3.50 M WIDE ROAD ON RECLAIMED LAND

ISSUED FOR TENDER

REV.	DATE	REVISION/DETAILS	DRN	CHK	APP

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPATING AGEN: DIMENSIONS ARE IN M
 PURPOSE:
 DRAWING TITLE:

SHEET	01 OF 01
DRAWING NUMBER	80814746-DWG-TD-0000-PL-3014
REV.	0

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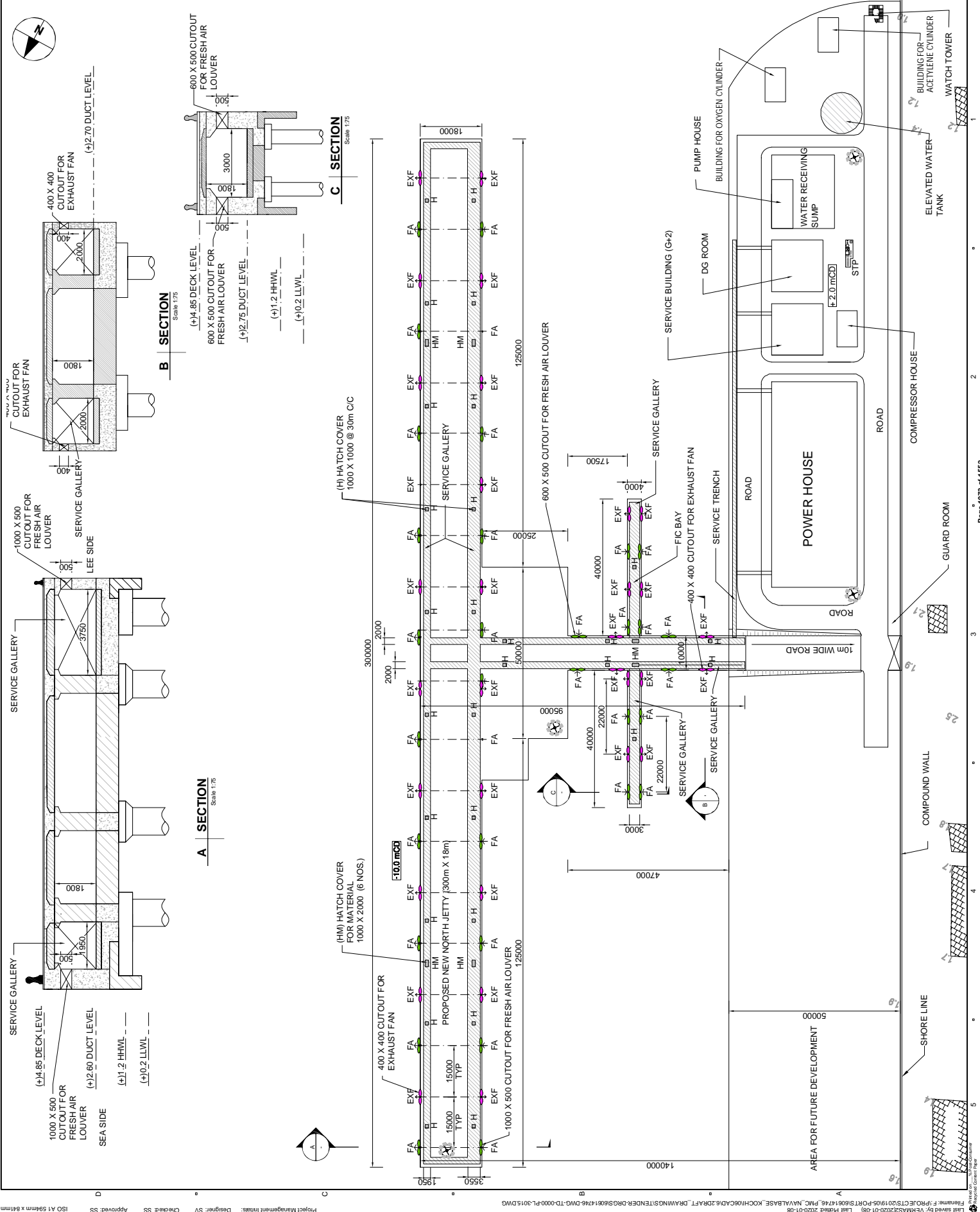
NOTES:
 1 ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SPECIFIED

LEGEND:
 EXF CUTOUT FOR EXHAUST FAN
 FA CUTOUT FOR FRESH AIR LOUVER
 H HATCH COVER
 HM HATCH COVER FOR MATERIAL

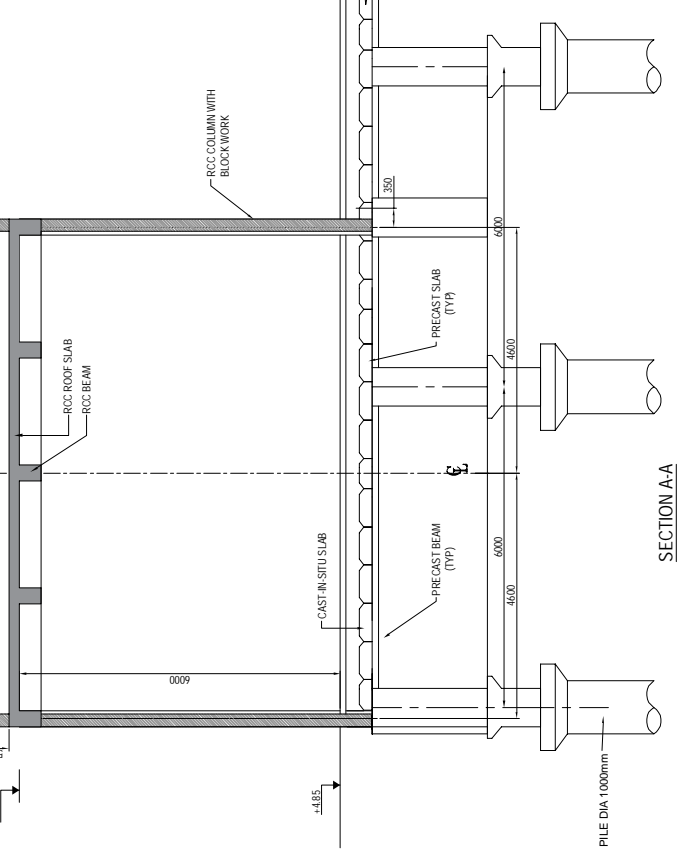
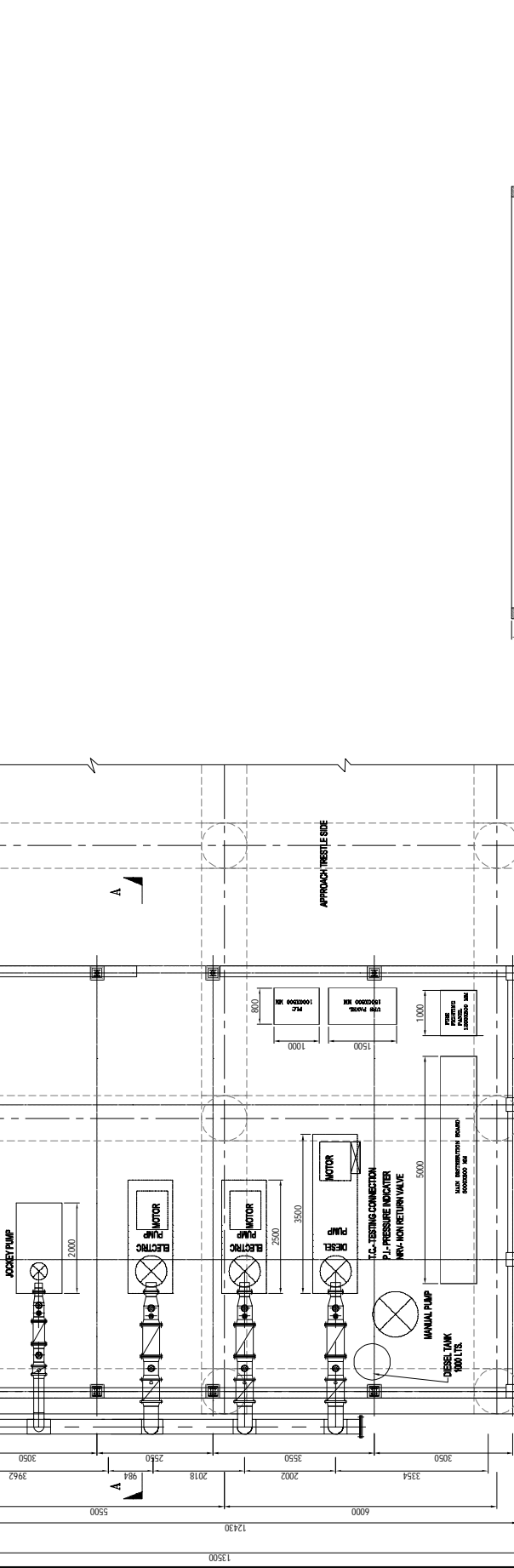
ISSUED FOR TENDER

REV	DATE	REVISION	BY	CHK	APP

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPATION: DIVISIONS/AREA: PURPOSE: DRAWING TITLE: LAYOUT OF VENTILATION SYSTEM
 DRAWING NUMBER: 80814746-DWG-TD-0000-PL-3015
 REV: 0



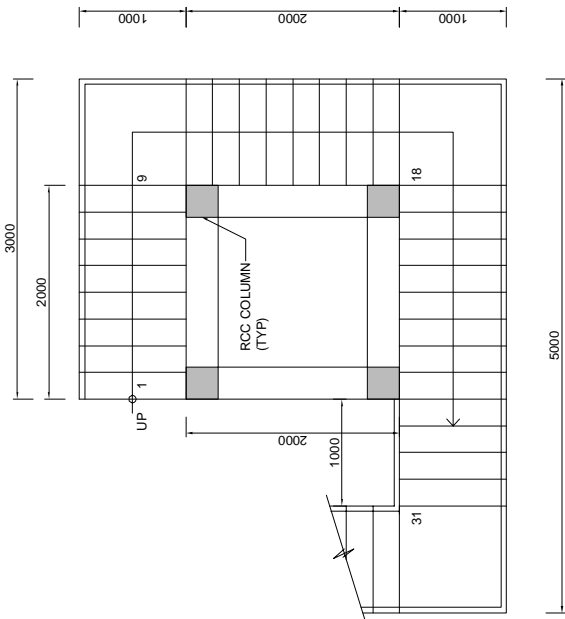
NOTES:
 1 ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SPECIFIED



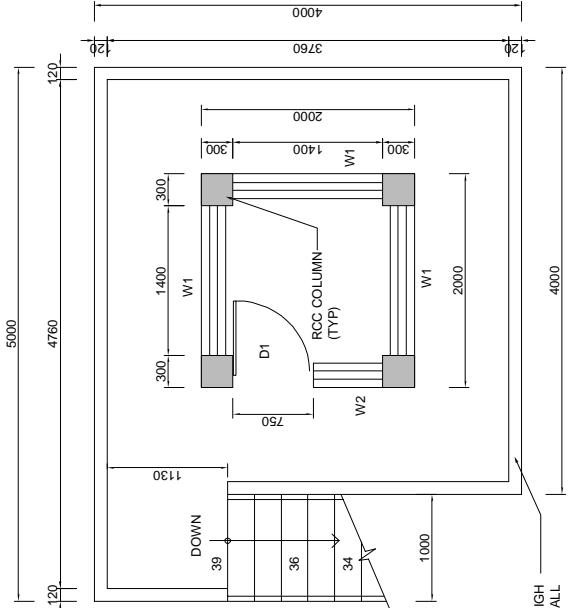
NOTES:
 1 ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS (M) UNLESS OTHERWISE SPECIFIED.
 2 DIMENSIONS, LEVELS, SLOPES, etc. SHALL BE VERIFIED BEFORE LAYING SOIL AND LINER WORKS.

ISSUED FOR TENDER

REV.	DATE	REVISIONS	DRN	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE:					
PURPOSE:					
DRAWING TITLE: DETAILS OF WATCH TOWER					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-3018					
REV: 0					

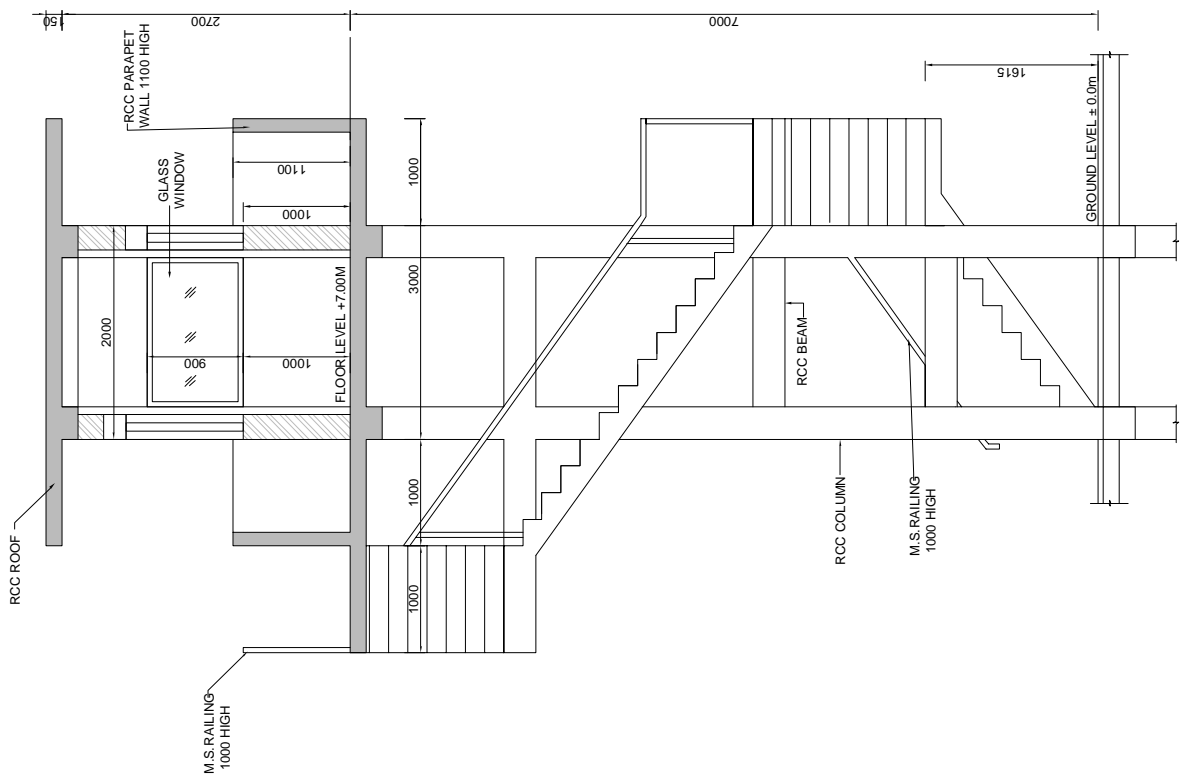


STAIRCASE:-
 WIDTH = 1000
 RISER = 180 (APPROX.)
 TREAD = 250



SCHEDULE OF OPENINGS:

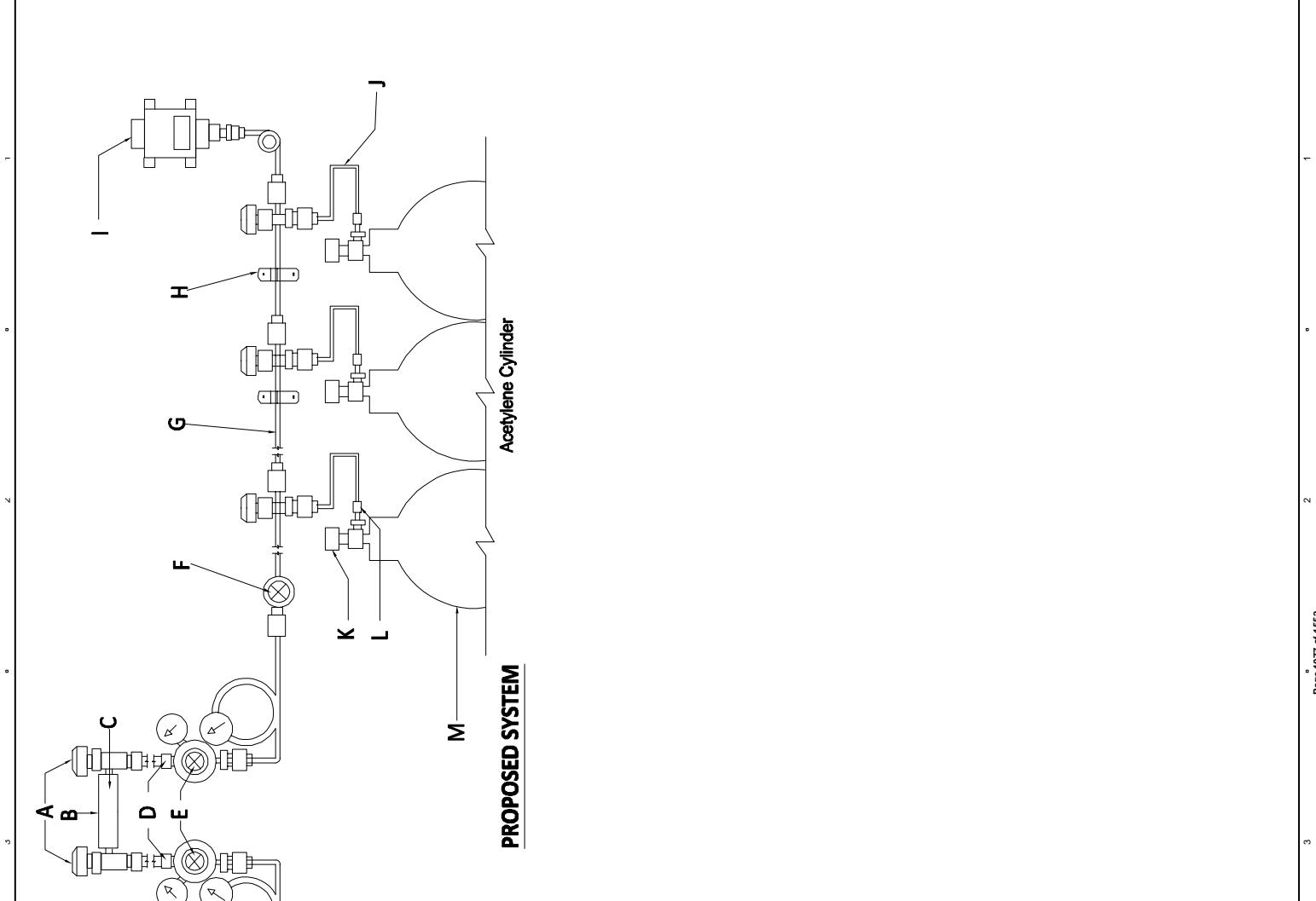
MARKED	WIDTH	HEIGHT	LINTEL LEVEL	SILL LEVEL
D1	750	2100	2100	-
W1	1400	900	1900	1000
W2	650	900	1900	1000



ISSUED FOR TENDER

REV. NO.	DATE	REVISION/DETAILS	DR. CHIT. / P.P.

OWNER: COCHIN PORT TRUST
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
PARTICULARS: DIMENSIONS ARE IN METERS
PURPOSE:
DRAWING TITLE: OXYGEN ACETYLENE PROPOSED SYSTEM
DRAWING NUMBER: 80014746-DWG-TD-0000-PL-4001
REV. NO.: 0



SPECIFICATIONS:-

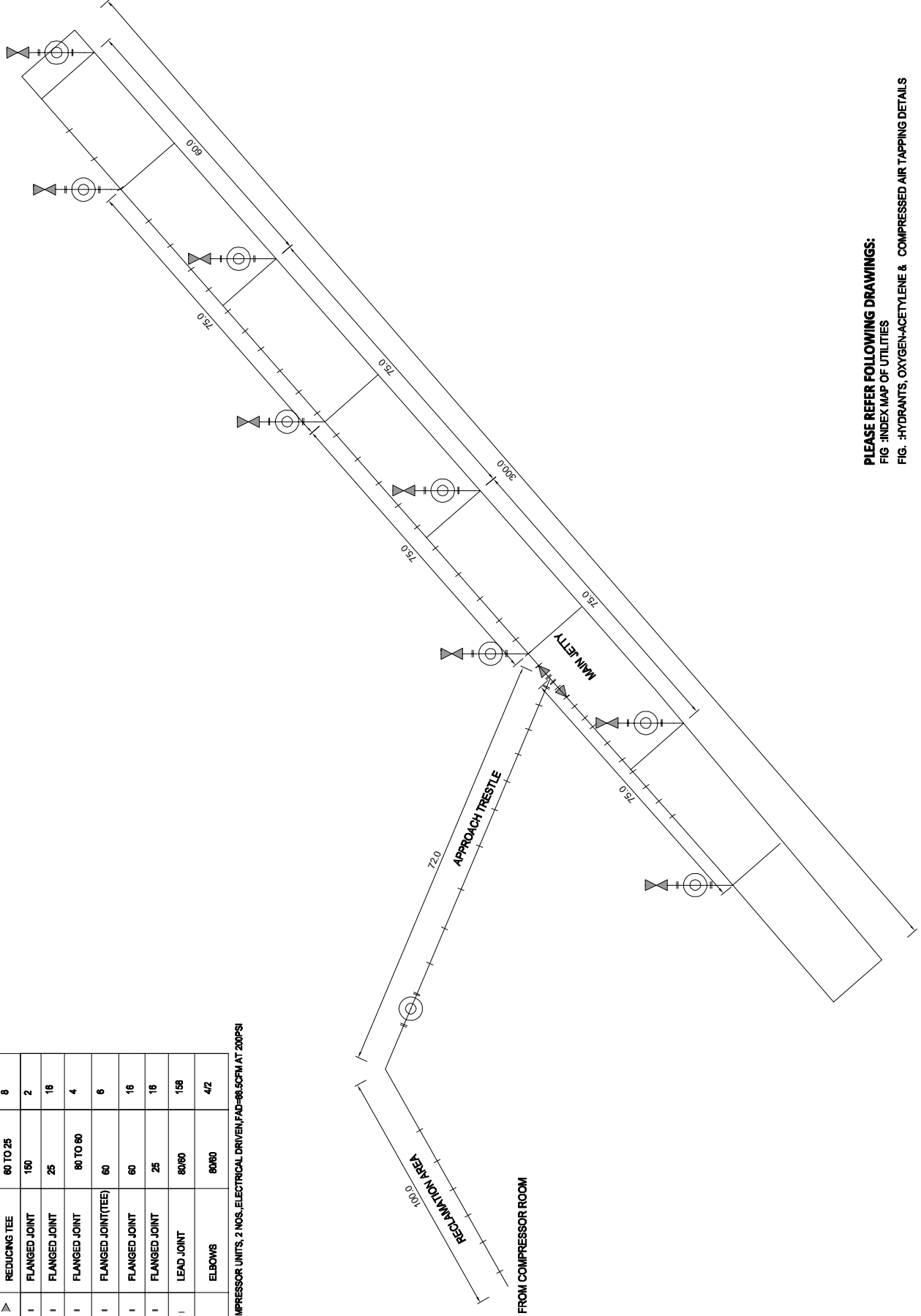
SYMBOL	NAME	SYMBOL	NAME
A	AC Master shut off valve	I	Optional Pressure Switch
B	1/2" NPTF Outlet Port	J	Cylinder Leads
C	Outlet Block	K	Cylinder Valve
D	Check Valve	L	Optional Check valve
E	Pressure Regulator	M	Cylinder
F	Shut off valve	N	Station Valve
G	Manifold Header	O	Press switch
H	Mount wall Brackets		



MAIN JETTY (TAPPING DETAILS)

MARK	PARTS OF SYS.	SIZE(NB),MM	Nos.
⊗	TAPPING OUTLETS	25	8
⊙	BALL VALVE(MAIN)	150	1
⊙	BALL VALVE(MAIN)	25	8
▲	REDUCER	80 TO 80	2
▲	REDUCING TEE	80 TO 25	8
┌	FLANGED JOINT	150	2
┌	FLANGED JOINT	25	18
┌	FLANGED JOINT	80 TO 80	4
┌	FLANGED JOINT(TEE)	60	6
┌	FLANGED JOINT	60	18
┌	FLANGED JOINT	25	18
┌	LEAD JOINT	80/80	158
┌	ELBOWS	80/80	4/2

COMPRESSOR UNITS, 2 NOS. ELECTRICAL DRIVEN, PAD=86.5CFM AT 200PSI

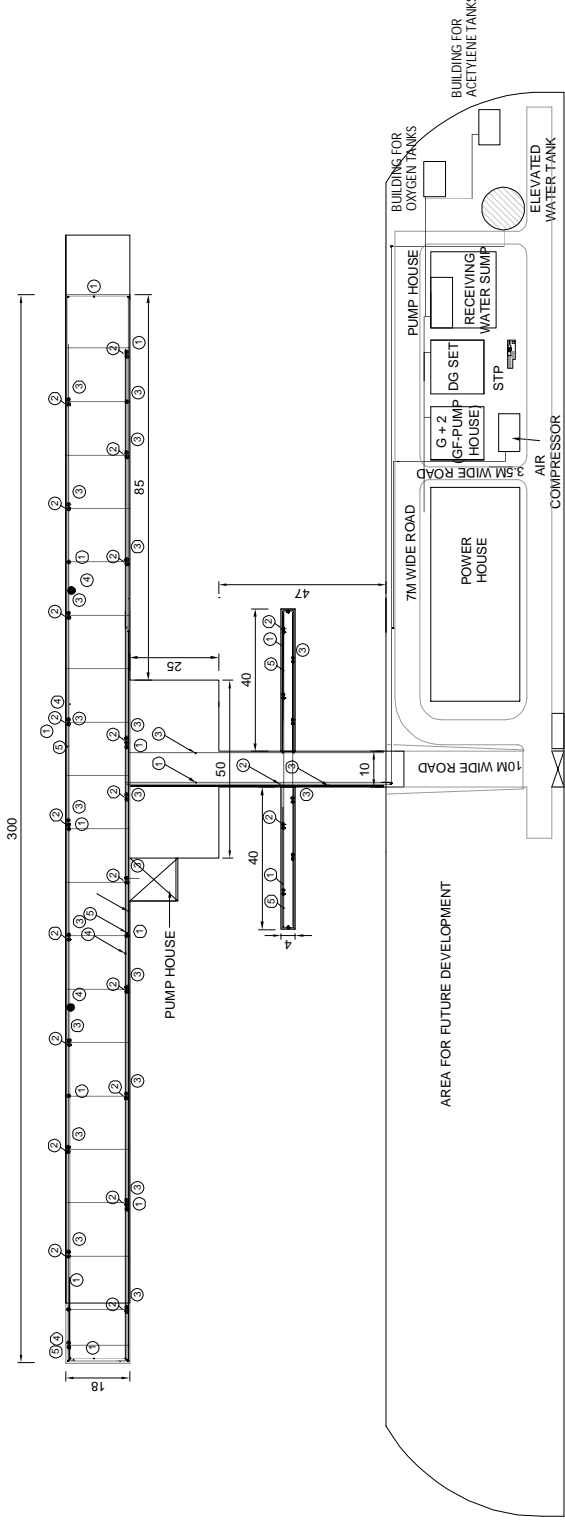


PLEASE REFER FOLLOWING DRAWINGS:
 FIG. INDEX MAP OF UTILITIES
 FIG. HYDRANTS, OXYGEN-ACETYLENE & COMPRESSED AIR TAPPING DETAILS

ISSUED FOR TENDER

REV.	DATE	REVISION	BY	CHK.	APP.
OWNER: COCHIN PORT TRUST PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI PARTICIPATION: DIMENSIONS ARE IN METERS PURPOSE:					
DRAWING TITLE: COMPRESSED AIR SYSTEM					
SHEET 01 OF 02					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4002					
REV: 0					

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 AECOM India Pvt. Ltd.



MAIN JETTY PIPE (UTILITIES) DETAILS:

MARK	SYSTEM	MATERIAL	DIA.(MM)	LENGTH(M)	TYPE
①	COMPRESSED AIR SYSTEM	GS	80	-	MAIN
②	FRESH WATER	DI	150	-	MAIN
③	FIRE WATER SYSTEM	DI	150	636	MAIN
④	COMPRESSED AIR SYSTEM	GS	60	618	DISTRIBUTORY
⑤	FRESH WATER	DI	100	618	DISTRIBUTORY

APPROACH TRESTLE (UTILITIES) DETAILS:

MARK	SYSTEM	MATERIAL	DIA.(MM)	LENGTH(M)	TYPE
①	COMPRESSED AIR SYSTEM	GS	80	72	MAIN
②	FRESH WATER	DI	150	72	MAIN
③	FIRE WATER SYSTEM	DI	150	144	MAIN
④	COMPRESSED AIR SYSTEM	GS	60	-	DISTRIBUTORY
⑤	FRESH WATER	DI	100	-	DISTRIBUTORY

FIG BAY (UTILITIES) DETAILS:

MARK	SYSTEM	MATERIAL	DIA.(MM)	LENGTH(M)	TYPE
⑤	FRESH WATER	DI	100	168	DISTRIBUTORY
①	FIRE WATER SYSTEM	DI	150	176	MAIN

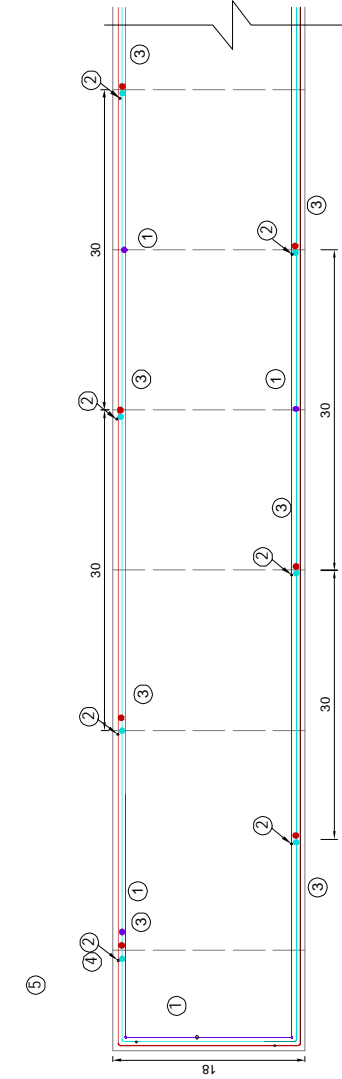
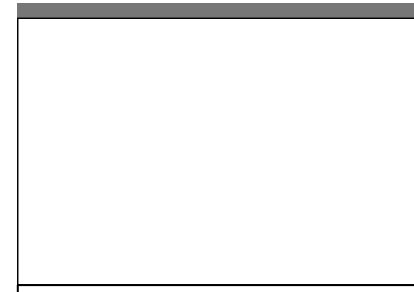
HYDRANTS AND TAPPING DETAILS:

MARK	SYSTEM	NOS.	DISTANCE(M)	FACE	JETTY
①	COMPRESSED AIR TAPPINGS	4/4(8)	75M C/C	SEA/LEE(TOTAL)	
②	WATER HYDRANTS	10/10(20)	30M C/C	SEA/LEE(TOTAL)	MAIN
③	FIRE HYDRANTS	10/10(20)	30M C/C	SEA/LEE(TOTAL)	
④	OXYGEN - ACETYLENE CYL	2/2 (4)	90M FROM EITHER SIDE	SEA/LEE(TOTAL)	
②	WATER HYDRANTS	(2/2(4)) X2	20M C/C	SEA/LEE(TOTAL)	
③	FIRE HYDRANTS	(2/2+1(5)) X2	20M C/C & 1 AT CENTER	SEA/LEE(TOTAL)	FIC

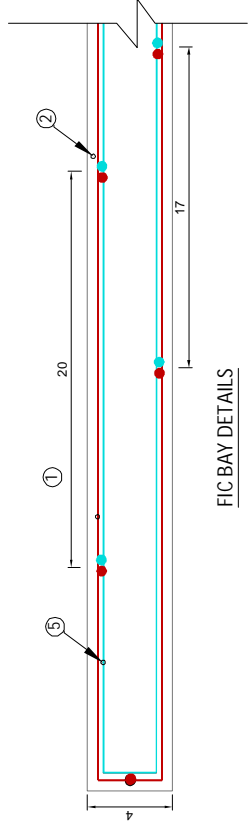
ISSUED FOR TENDER

NO.	DATE	REVISION	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RE-CONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS: HYDRANTS, OXYGEN-ACETYLENE AND COMPRESSED AIR TAPPING DETAILS					
DRAWING NUMBER: SHEET 1					
REV.	NO.	DESCRIPTION	DATE	BY	CHK

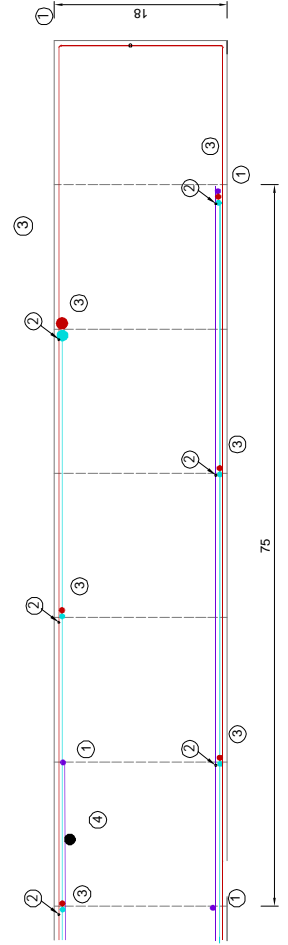




DETAIL-A (MAIN JETTY)



FIC BAY DETAILS



DETAIL-B (MAIN JETTY)

MAIN JETTY PIPE (UTILITIES) DETAILS:

MARK	SYSTEM	MATERIAL	DIA.(mm)	LENGTH(m)	TYPE
①	Compressed Air system	GS	80	-	MAIN
②	Fresh Water	DI	150	-	MAIN
③	Fire Water System	DI	150	636	MAIN
④	Compressed Air system	GS	60	618	DISTRIBUTORY
⑤	Fresh Water	DI	100	618	DISTRIBUTORY

FIC BAY (UTILITIES) DETAILS:

MARK	SYSTEM	MATERIAL	DIA.(mm)	LENGTH(m)	TYPE
⑤	Fresh Water	DI	100	168	DISTRIBUTORY
①	Fire Water System	DI	150	168	MAIN

HYDRANTS AND TAPPING DETAILS:

MARK	SYSTEM	Nos.	Distance(m)	FACE	JETTY
①	Fire Hydrants	10/10(20)	30m c/c	SEA/EE(TOTAL)	JETTY
②	Water Hydrants	10/10(20)	30m c/c	SEA/EE(TOTAL)	MAIN
③	Compressed Air Tappings	4/4(8)	75m c/c	SEA/EE(TOTAL)	MAIN
④	Oxygen - Acetylene Cyl.	2/2 (4)	100m from either side	SEA/EE(TOTAL)	MAIN
①	Fire Hydrants	(2/2-1(5)) X2	20m c/c & 1st center	SEA/EE(TOTAL)	FIC
②	Water Hydrants	(2/2(4)) X2	20m c/c	SEA/EE(TOTAL)	FIC

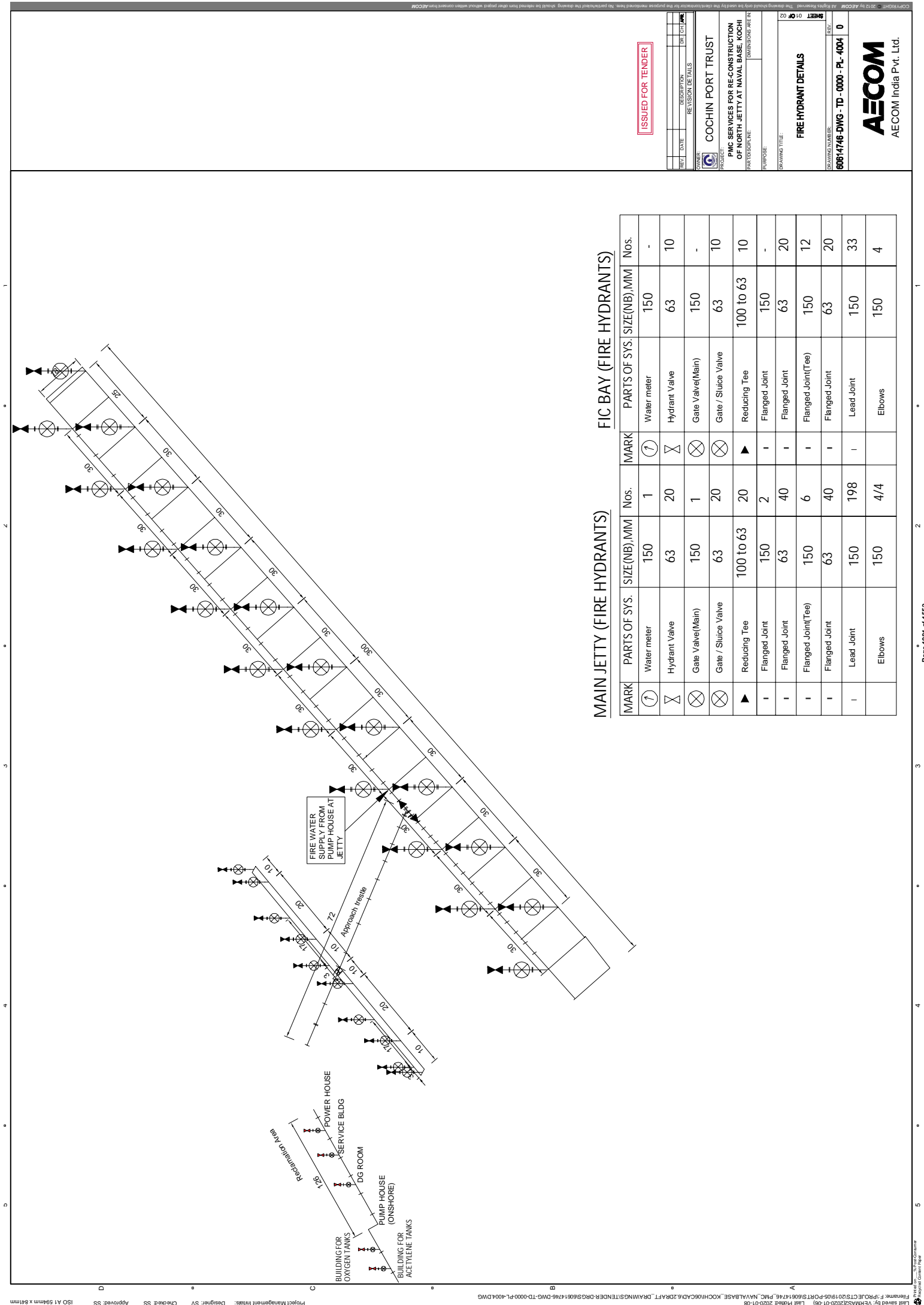
PLEASE REFER FOLLOWING DRAWINGS:
 FIG. INDEX MAP OF UTILITIES
 FIG. MASTER PLAN (DESIGN FOLDER DRAWING)

ISSUED FOR TENDER

REV.	DATE	REVISION	DR.	CHK.	APP.
		REVISION DETAILS			

OWNER: COCHIN PORT TRUST
 PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
 PARTICIPANTS: A/E/P
 DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4003
 SHEET: 02 OF 02
 SHEET TITLE: HYDRANTS, OXYGEN-ACETYLENE AND COMPRESSED AIR TAPPING DETAILS
 SHEET 2
 DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4003
 REV: 0



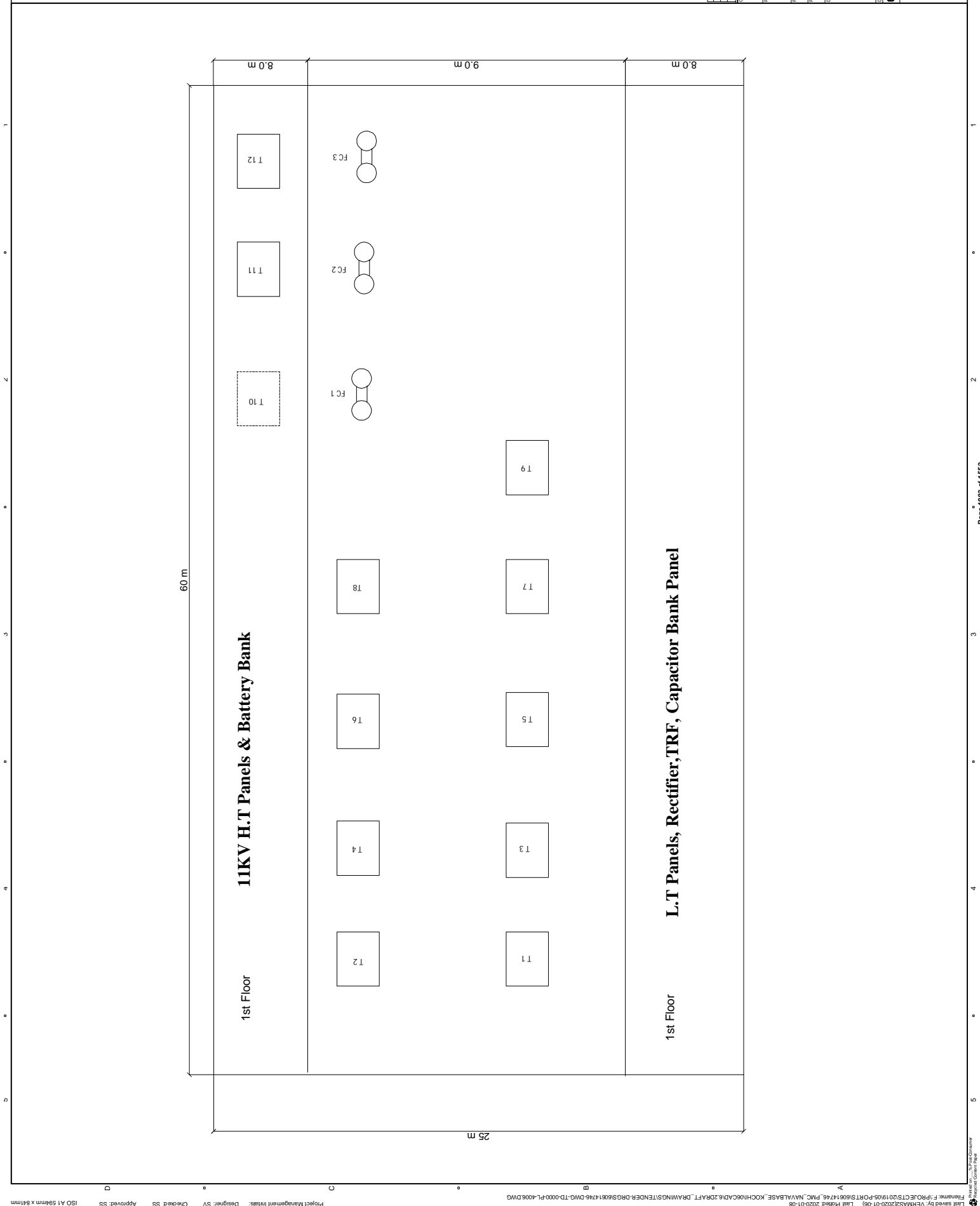


MAIN JETTY (FIRE HYDRANTS)

MARK	PARTS OF SYS.	SIZE(NB),MM	Nos.	MARK	PARTS OF SYS.	SIZE(NB),MM	Nos.
①	Water meter	150	1	①	Water meter	150	-
⊗	Hydrant Valve	63	20	⊗	Hydrant Valve	63	10
⊗	Gate Valve(Main)	150	1	⊗	Gate Valve(Main)	150	-
⊗	Gate / Sluice Valve	63	20	⊗	Gate / Sluice Valve	63	10
▶	Reducing Tee	100 to 63	20	▶	Reducing Tee	100 to 63	10
┆	Flanged Joint	150	2	┆	Flanged Joint	150	-
┆	Flanged Joint	63	40	┆	Flanged Joint	63	20
┆	Flanged Joint(Tee)	150	6	┆	Flanged Joint(Tee)	150	12
┆	Flanged Joint	63	40	┆	Flanged Joint	63	20
┆	Lead Joint	150	198	┆	Lead Joint	150	33
	Elbows	150	4/4		Elbows	150	4

FIC BAY (FIRE HYDRANTS)

MARK	PARTS OF SYS.	SIZE(NB),MM	Nos.	MARK	PARTS OF SYS.	SIZE(NB),MM	Nos.
①	Water meter	150	1	①	Water meter	150	-
⊗	Hydrant Valve	63	20	⊗	Hydrant Valve	63	10
⊗	Gate Valve(Main)	150	1	⊗	Gate Valve(Main)	150	-
⊗	Gate / Sluice Valve	63	20	⊗	Gate / Sluice Valve	63	10
▶	Reducing Tee	100 to 63	20	▶	Reducing Tee	100 to 63	10
┆	Flanged Joint	150	2	┆	Flanged Joint	150	-
┆	Flanged Joint	63	40	┆	Flanged Joint	63	20
┆	Flanged Joint(Tee)	150	6	┆	Flanged Joint(Tee)	150	12
┆	Flanged Joint	63	40	┆	Flanged Joint	63	20
┆	Lead Joint	150	198	┆	Lead Joint	150	33
	Elbows	150	4/4		Elbows	150	4



ISSUED FOR TENDER

NO.	DATE	REVISION	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST PROJECT: PMC SERVICES FOR RE-CONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI PARTICIPATION LINE: _____ DIMENSIONS AREA: _____ PURPOSE: _____ DRAWING TITLE: _____					
SUBSTATION LAYOUT					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4006					
REV: 0					
 AECOM India Pvt. Ltd.					

ISSUED FOR TENDER

REV	DATE	REVISION/DETAILS	DRN	CHK	APP

OWNER: **COCHIN PORT TRUST**

PROJECT: **PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI**

PART/DISCIPLINE: **DIMENSIONS AREA**

PURPOSE:

DRAWING TITLE:

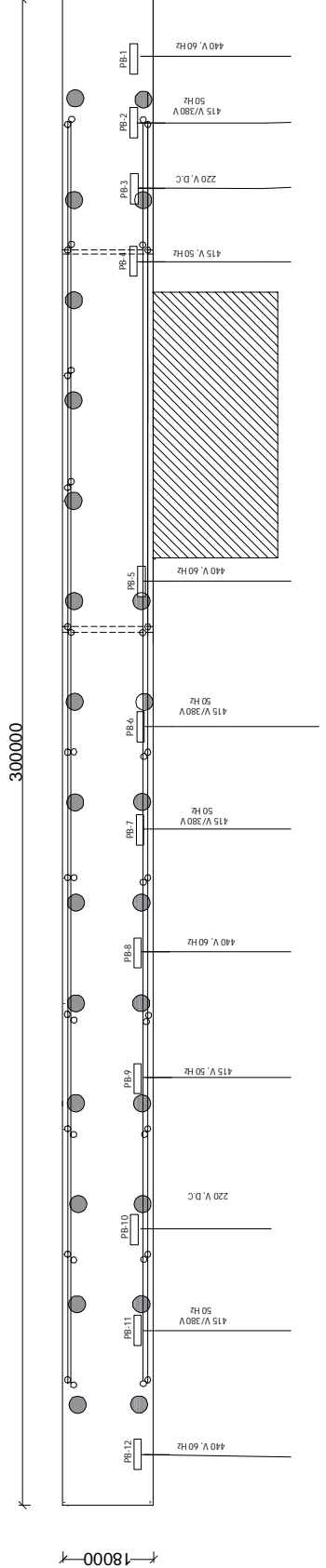
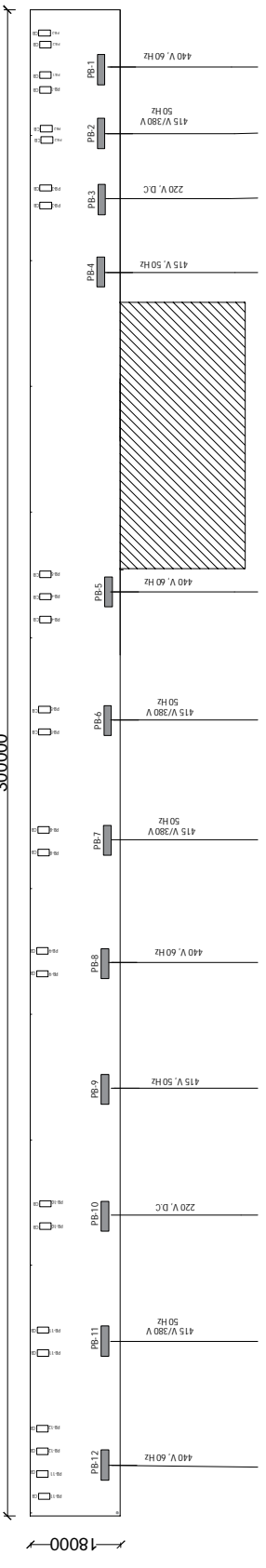
DRAWING NUMBER: **80014746-DWG-TD-0000-PL-4007**

REV: **0**

SHEET: **01** OF **01**

LOCATION OF PILLAR BOXES AND COPE BOXES

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- Fresh water hydrants
 - Fresh water hydrants
 - Pillar box
 - Bollards
- NOTE:
All dimensions in mm

ISSUED FOR TENDER

REV.	DATE	REVISION	BY	CHK.	APP.
REVISION DETAILS					

OWNER: COCHIN PORT TRUST

PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI

PARTICULARS OF THE DRAWING: DIMENSIONS ARE IN METERS

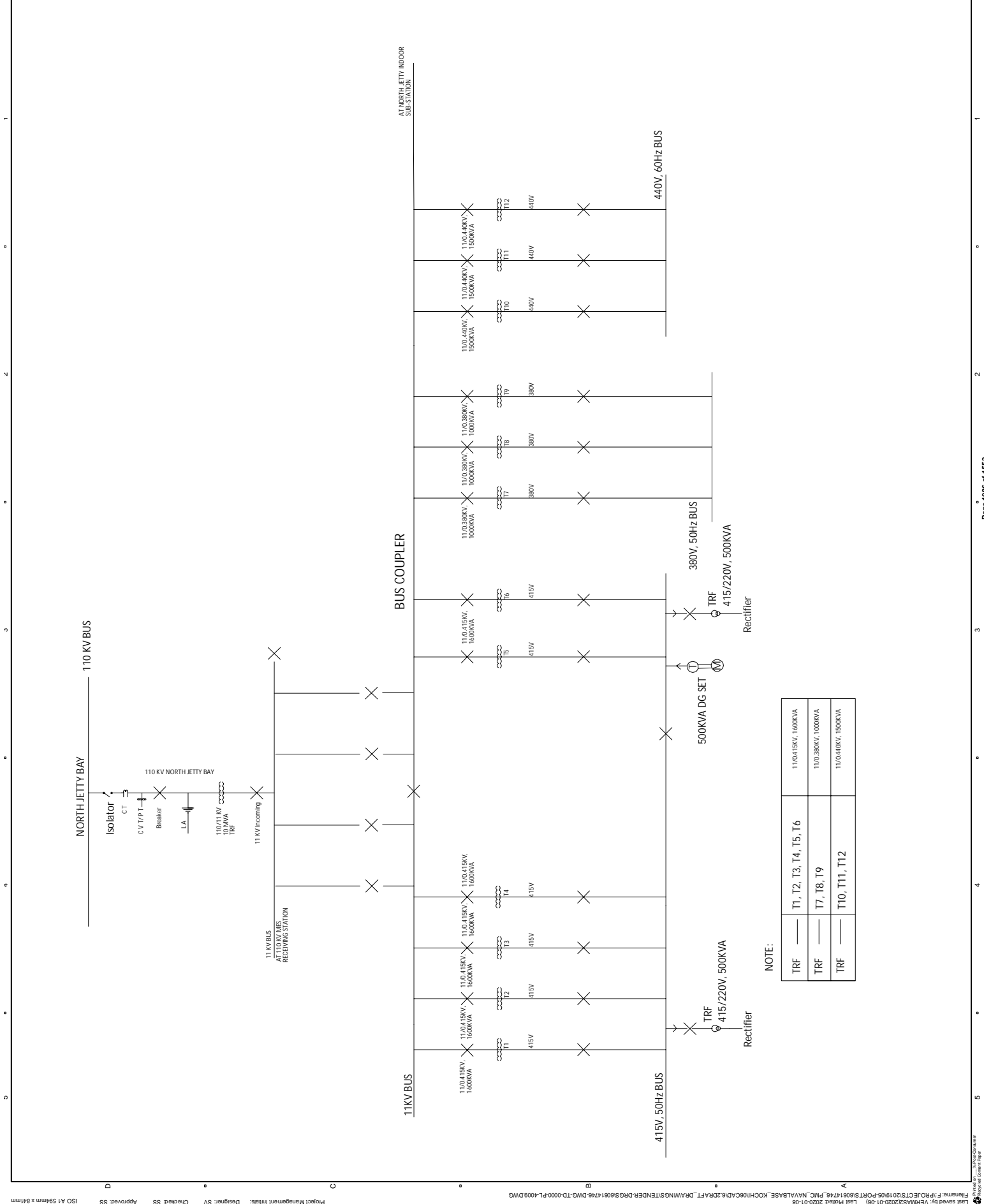
DATE: 01/01/2012

DRAWING TITLE: SINGLE LINE DIAGRAM PROPOSED POWER SUPPLY DIAGRAM FOR NORTH JETTY

DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4009

REV: 0

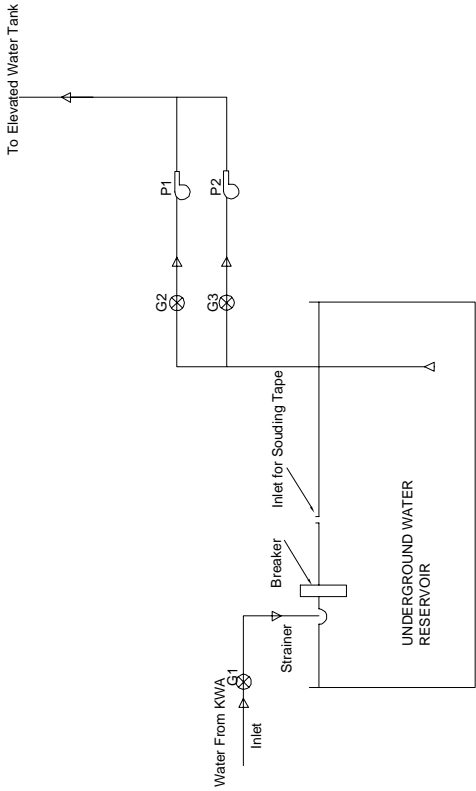
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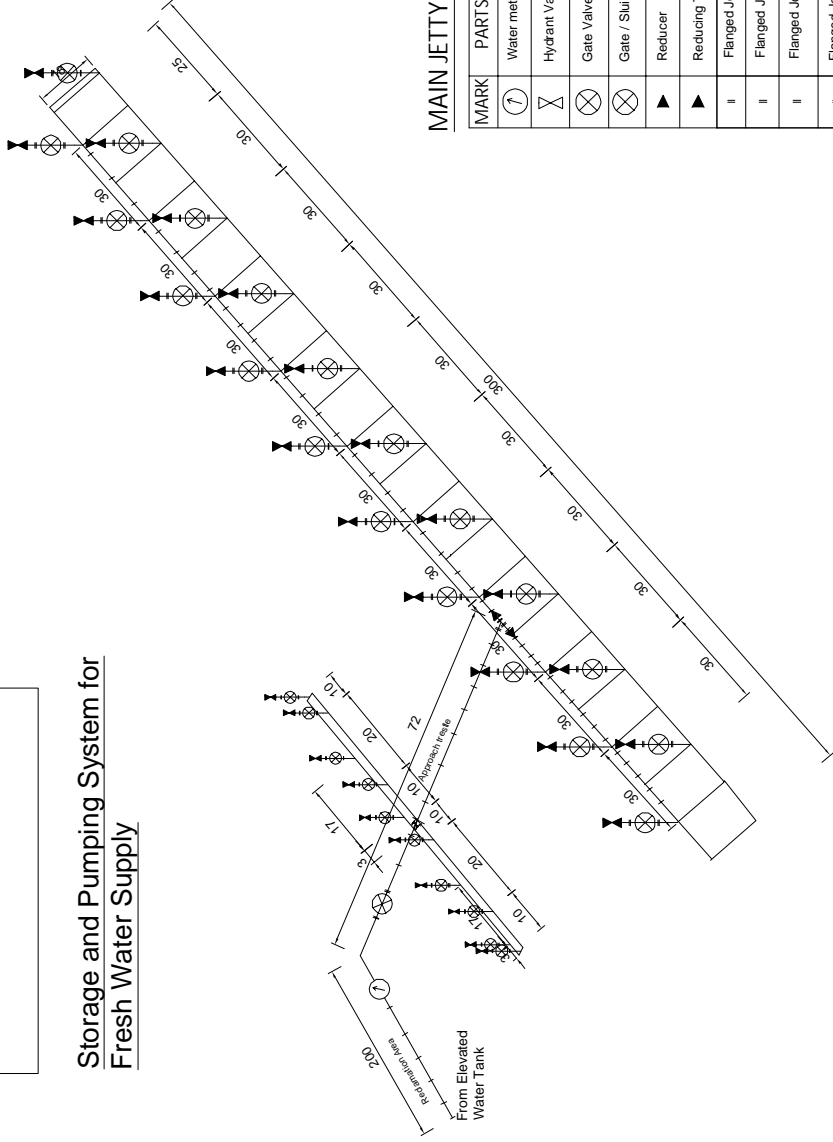
STORAGE AND PUMPING SYSTEM

PARTS OF SYS.	Nos.
STORAGE TANKS	600 t
GATES	3
BREAKER	1
ELEVATED TANK	1

PUMP/CENTRIFUGAL PUMPS, 2 NOS..ELECTRICAL DRIVEN(INDUCTION MOTOR).50M HEAD,1080 Lit./Min.



Storage and Pumping System for Fresh Water Supply



MAIN JETTY (WATER HYDRANTS)

MARK	PARTS OF SYS.	SIZE(NB),MM	Nos.
(1)	Water meter	150	1
(2)	Hydrant Valve	63	20
(3)	Gate Valve(Main)	150	1
(4)	Gate / Sluice Valve	63	20
(5)	Reducer	150 to 100	2
(6)	Reducing Tee	100 to 63	20
(7)	Flanged Joint	150	2
(8)	Flanged Joint	63	40
(9)	Flanged Joint	150 to 100	4
(10)	Flanged Joint(Tee)	150	6
(11)	Flanged Joint	100	40
(12)	Flanged Joint	63	40
(13)	Lead Joint	150/100	178
(14)	Elbows	150/100	3/2

FIC BAY (WATER HYDRANTS)

MARK	PARTS OF SYS.	SIZE(NB),MM	Nos.
(1)	Water meter	150	-
(2)	Hydrant Valve	63	10
(3)	Gate Valve(Main)	150	-
(4)	Gate / Sluice Valve	63	10
(5)	Reducer	150 to 100	4
(6)	Reducing Tee	100 to 63	10
(7)	Flanged Joint	150	-
(8)	Flanged Joint	63	20
(9)	Flanged Joint	150 to 100	8
(10)	Flanged Joint(Tee)	150	12
(11)	Flanged Joint	100	20
(12)	Flanged Joint	63	20
(13)	Lead Joint	150/100	34
(14)	Elbows	100	4

ISSUED FOR TENDER

NO.	DATE	REVISION	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE IN DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE: WATER SUPPLY SYSTEM					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4010					
REV.					
0					



NOTES:
 1 ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SPECIFIED
 3 ALL COORDINATES ARE GIVEN IN METRES RELATING TO UTM PROJECTION, SPHEROID WGS 84

LEGEND:

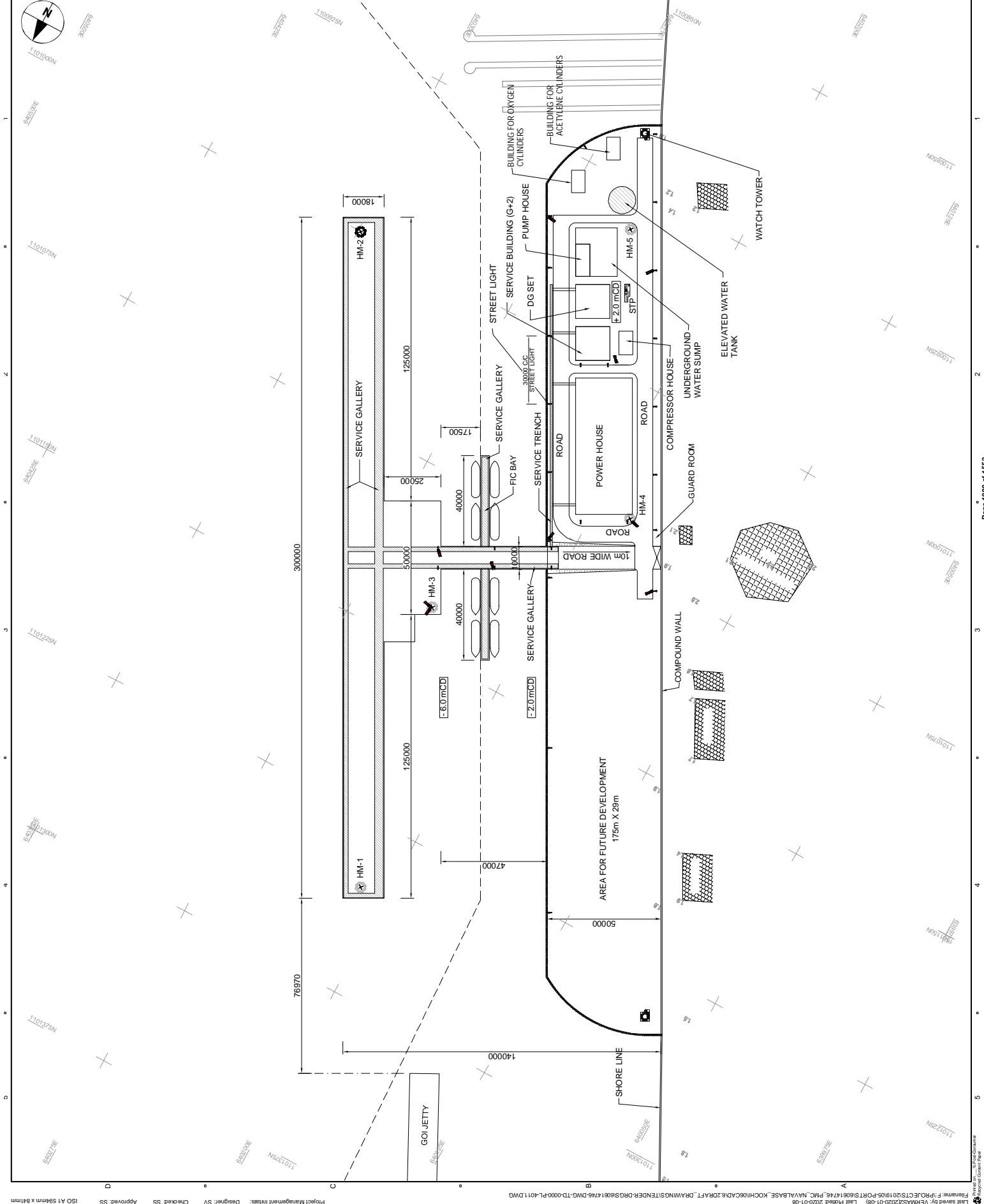
- HM-4 HIGH MAST
- STREET LIGHT
- CCTV CAMERA

ISSUED FOR TENDER

REV.	DATE	DESCRIPTION	BY	CHK.	APP.

OWNER: COCHIN PORT TRUST
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI
PARTICULARS: DIMENSIONS ARE IN METRES
PURPOSE:
DRAWING TITLE: LAYOUT OF THE LIGHT MAST CCTV CAMERA AND STREET LIGHTS
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4011
REV: 0

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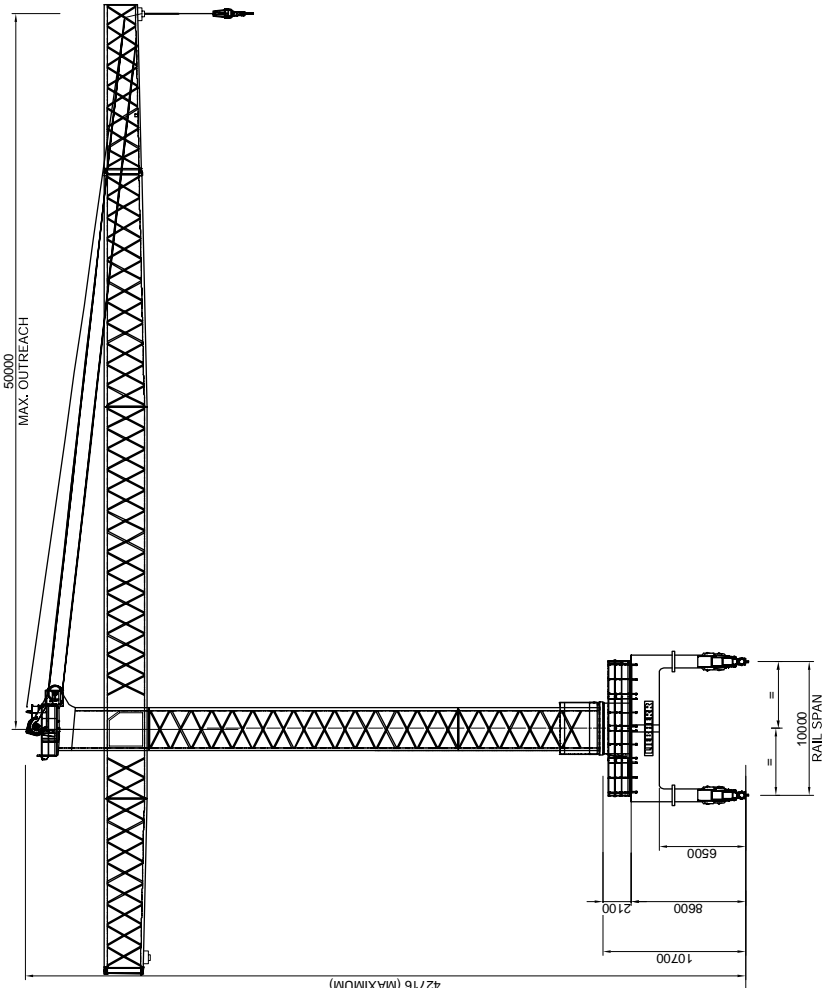


NOTES:
 1 ALL LEVELS ARE IN METRES AND ARE WITH RESPECT TO CHART DATUM.
 2 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SPECIFIED

ISSUED FOR TENDER

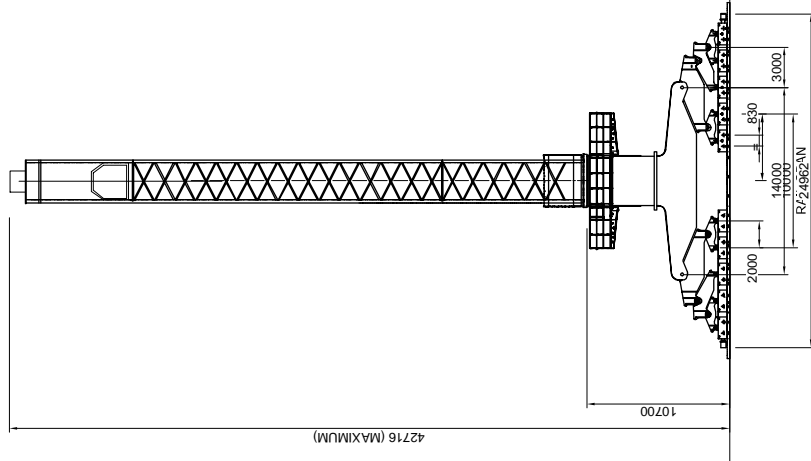
REV	DATE	REVISION	BY	CHK	APP
REVISION DETAILS					
OWNER: COCHIN PORT TRUST					
PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI					
PARTICULARS ARE IN DIMENSIONS ARE IN					
PURPOSE:					
DRAWING TITLE: GENERAL ARRANGEMENT OF RAIL MOUNTED CRANE					
DRAWING NUMBER: 80814746-DWG-TD-0000-PL-4013					
REV: 0					
SHEET 01 OF 01					

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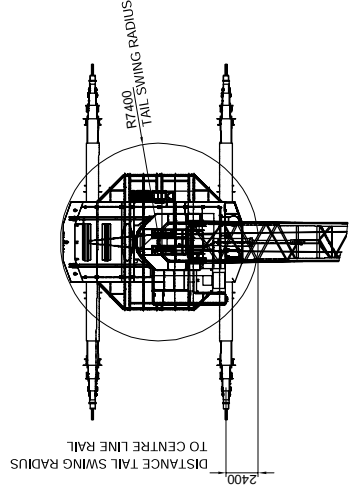


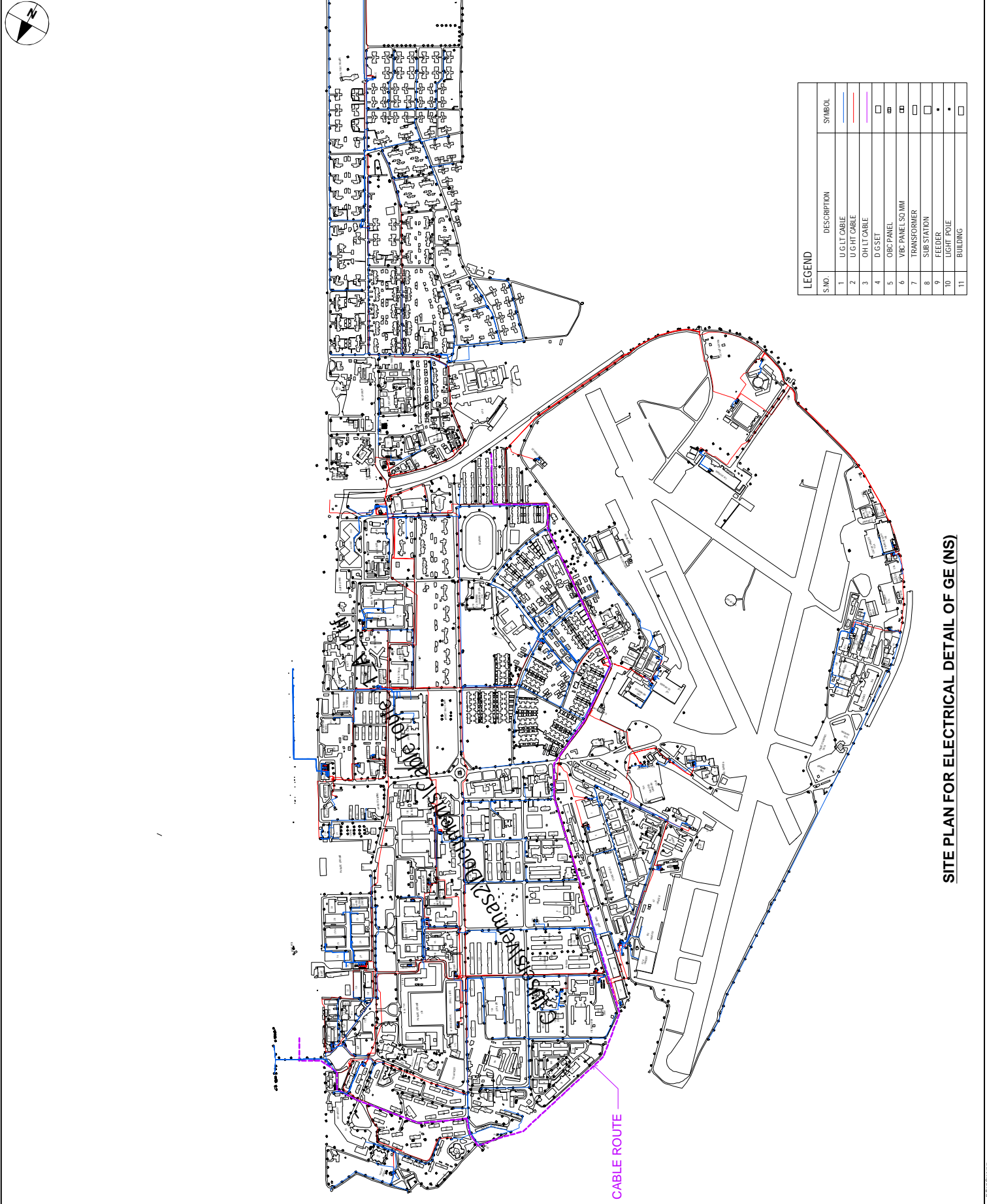
- REFERENCES:**
- General tolerances ISO 2768 - mk - E
 - General tolerances for welded constructions ISO 13920 - BF
 - Indication of surface texture in technical product documentation ISO 1302
 - Relationship between dimensional tolerances and form and parallelism tolerances DIN 7167

"SEASIDE"
 CONFIGURATION: 10 WHEELS (5 BOGIES) PER CORNER



"LANDSIDE"
 CONFIGURATION: 10 WHEELS (5 BOGIES) PER CORNER





LEGEND

S.NO.	DESCRIPTION	SYMBOL
1	U G/LT CABLE	
2	U G/H T CABLE	
3	O/H LT CABLE	
4	D/G SET	
5	ODC/PANEL	
6	V/B C/PANEL/50 MM	
7	TRANSFORMER	
8	SUB STATION	
9	FEEDER	
10	LIGHT POLE	
11	BUILDING	

ISSUED FOR TENDER

REV	DATE	REVISION/DETAILS	DR	CHK	APP

OWNER: COCHIN PORT TRUST

PROJECT: PMC SERVICES FOR RECONSTRUCTION OF NORTH JETTY AT NAVAL BASE, KOCHI

PARTICULARS: DIMENSIONS ARE IN METERS

DRAWING TITLE: SITE PLAN FOR RECONSTRUCTION OF NORTH JETTY 9/8 CABLE ROUTE

DRAWING NUMBER: 80814746-DWG-TD-0000-CS-4014

REV: 0

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SITE PLAN FOR ELECTRICAL DETAIL OF GE (NS)