LEBANESE REPUBLIC

GENERAL DIRECTORATE OF THE PRESIDENCY

PRESIDENTIAL PALACE COMPOUND — BAABDA

REHABILITATION OF MAIN ELECTRICAL ROOM & NEW GENERATORS ROOM

IN THE PRESIDENTIAL PALACE

TENDER DOCUMENTS

Technical Specifications

Unpriced Bill of Quantities

Drawings

PROJECT REFERENCE L2026-14/2026

SOURCE DOCUMENT REVISION R1 | OCTOBER 2026

Consolidated technical document set

9 source files • Original pages and drawing sizes retained

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L2026-14/2026 | Consolidated technical document set

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TENDER DOCUMENTS

VOLUME 2

TECHNICAL SPECIFICATIONS

CIVIL, STRUCTURE AND ARCHITECTURAL – R1

L2026-14/2026

Prepared by

October - 2026

SPECTRUM ENGINEERING CONSULTANTS S.A.R.L.

ISO 9001:2000

REHABILITATION OF MAIN ELECTRICAL ROOM / NEW GENERATORS ROOM IN RESIDENTIAL PALACE

VOLUME 2 : TECHNICAL SPECIFICATIONS

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Summary of the Works

SECTION 011100
SUMMARY OF THE WORKS

Part 1 - GENERAL

1.01 SECTION INCLUDES

A. Introduction
B. Location of the Site
C. Scope of Work for this Contract
D. Work performed under other Contracts
E. Future Work
F. Work Sequence/Phases if any
G. Special Conditions

1.02 INTRODUCTION

The presidential compound need to rehabilitation of the existing Electrical Room and construction of new Generator Room within the Presidential Compound.

1.03 LOCATION OF THE SITE

A. The New generator room and the electrical room are located in the services block within the Presidential Compound.

1.04 SCOPE OF WORK FOR THIS CONTRACT

A. The scope of work under this Contract comprises the complete construction, rehabilitation, modification, supply, installation, testing, commissioning, completion, furnishing, handover, and maintenance of the rehabilitated Electrical Room and new Generator Room, including all associated facilities and temporary works.

B. The Contractor shall provide all labor, supervision, materials, equipment, plant, tools, temporary works, protection, testing facilities, and services necessary to complete the Works.

C. The Works shall include, but shall not necessarily be limited to, the following:

Existing Electrical Room Rehabilitation:

1. Inspection, assessment, and verification of existing conditions.
2. Demolition and removal of identified existing installations.
3. Rehabilitation and upgrading of electrical installations and equipment.
4. Installation of new switchgear, panels, cabling, protection, metering, earthing, and accessories.
5. Waterproofing, painting, finishing, and making good.
6. Testing and commissioning of all systems.

New Generator Room:

1. Site preparation, excavation, foundations, and civil works.
2. Construction and finishing of the Generator Room.
3. Installation of generator, control systems, cabling, and accessories.
4. Testing, commissioning, and handover of the complete installation.

1.05 WORK PERFORMED UNDER OTHER CONTRACTS

A. The Employer may during the execution of these works employ “Other Contractors” on a direct contract basis to execute other works currently associated with and making project functional.

B. The Contractor shall allow for all costs in connection with scheduling and executing his construction operations in conjunction with Works by the above Other Contractors, if appointed and shall cooperate and coordinate therewith.

C. Items indicated on drawings as NIC (Not in Contract) are not included in this Contract but the Contractor must provide "roughing in” (Builders Work in Connection) services for NIC items.

D. Cooperate and Coordinate fully with Other Contractors so that work under those Contracts may be carried out smoothly, without interfering with or delaying work under this Contract.

1.06 PROGRAMME

A. It is recognized that the required programme is challenging. Notwithstanding, the required programme dates are absolute and are non-negotiable. The Contractor’s programme must clearly show the proposed shift pattern if any.

B. The Contractor shall be deemed to be fully cognizant of the challenging programme, and shall be deemed to have fully priced for compliance therewith. No claim whatsoever relating to meeting the programme dates shall be entertained.

1.07 WORK SEQUENCE/PHASES IF ANY

A. Construct, Equip and Furnish Works in sequence/phases to accommodate Employer’s occupancy requirements, and in compliance with the Contractor’s Schedule as per requirements of the Contract as well as stated in the Terms of Reference.

1.08 SITE WORK WITH EXISTING CONDITIONS

A. Contractor's use of Site

1. The site of the work is at location/s areas where the electrical room.
   a. The Contractor is required to organize his operations in such a way that disruption of access to contiguous properties and interference with existing services and improvements is minimized and special care should be takes for the location of the work.
   b. The Contractor will be required to describe his operations to avoid disruption, inconvenience and nuisance, in a detailed Method Statement, which will be subject to the approval of the ENGINEER.

2. The Contractor shall ensure that roads and thoroughfares used by him for the transportation of construction plant, labor, materials, or debris are not soiled because of his operations and the contractor should submit all infrastructure to the secure entrance permit to the site. If, in the opinion of the ENGINEER, the Contractor's operations result in dirty conditions, the Contractor, upon notification, shall take all necessary steps to clean or repair roads and thoroughfares at no extra cost to the Employer.

3. Access to the work sites shall be maintained by the Contractor at all times and he shall take all necessary steps to ensure the safety of persons on the sites.

4. All construction operations and site established facilities shall be confined within the site boundaries as shown on the drawings, unless otherwise approved by the ENGINEER and the relevant authorities. Following such approvals, all such areas shall also be designated and treated as included within the Site.

5. The Contractor shall be responsible for safeguarding all structures, plant or property in the vicinity of the site and shall provide all shoring, or supports as may be necessary to preserve their stability.

6. The Contractor shall also ascertain from the public utility authorities, the positions of all existing underground services and he shall maintain and protect or divert them as required.

7. The Contractor shall note that existing underground services are not always in the exact position and depth as shown on the record drawings (if any). The Contractor shall allow for the full ramifications of any differences in position and depth.

8. Presidential authorities will serve the necessary notices to permit the work in private lands in accordance with the agreed programme of work and the Contract. Entry onto private lands is not permitted, until permission has been given by the ENGINEER.

9. The Contractor must use the site only for the construction of the work.

10. It is forbidden to disturb any trees, bushes or plants without permission from the relevant authorities.

11. Do not display, or permit advertisements to be displayed on site

B. Reinstatement of Surfaces

1. The Contractor should note that reinstatement is required to all surfaces disturbed during the construction works and all reinstatement is deemed to be entirely covered by the Contractor's rates.

2. Temporary reinstatement must be provided and maintained for the duration of the Contract or until the permanent reinstatement is carried out.

3. All roadways, footpaths, landscaped surfaces, car ports/ sheds and other areas disturbed by the Contractor’s construction works shall be restored.

4. The Contractor shall take a sufficient number of digital photographs prior to beginning construction to ensure that all surfaces and existing conditions are recorded in detail, to determine the minimum standard of reinstatement required after construction.

C. Utility Replacement

1. The Contractor shall reinstate all areas disturbed by the Works.
2. Temporary reinstatement shall be provided where permanent reinstatement cannot immediately be completed.
3. Before commencing construction, the Contractor shall take sufficient digital photographs of existing conditions to establish the condition of affected areas.

Where such utilities are disturbed these are to be reinstated in their existing condition/s and such reinstatement/s is deemed to be entirely covered by the Contractor’s Tender Price.

D. Materials

1. The Contractor shall submit lists of manufacturers and suppliers he proposes to use for the materials required for this Contract.

2. The Contractor must do all necessary coordination with the electrical and all other facilities.

3. See appropriate sections within the technical specifications.

E. Execution

1. Refer to the relevant sections for the execution of the works

2. Non-Compliant Or Defective Works: When any part of work is known to be, or suspected to be, defective, the Contractor shall submit proposals as soon as possible to the ENGINEER for his approval, for further testing, opening up, inspection, repair or removal and re-execution.

1.09 SPECIAL CONDITIONS

A. Any ambiguity, repetition, similarity or confusion shall be clarified by the ENGINEER in response to queries raised by the tenderer during the Tender Period.

B. Should the Contractor not solicit clarifications and/or interpretation before tender date this shall signify full and correct understanding of the tender documents by the Contractor. Further interpretation or clarification during the contract shall be provided by the ENGINEER. The ENGINEER’s decision shall be final.

1.10 VALUE ENGINEERING

A. Post contract signature, the Employer may at his sole discretion instruct the ENGINEER to carry out one or several Value Engineering exercises. The Contractor shall fully participate in all Value Engineering exercise(s) and shall be deemed to have priced for such participation. The Contractor shall deploy such staff as the ENGINEER requests to participate in the Value Engineering exercise(s).

B. Any cost saving generated by Value Engineering exercise shall be the share of the employe

C. Any Value Engineering exercises carried out pre-contract signature will not attract the above percentages, and all savings generated shall be received by the Employer.

1.11 INTERCHANGEABLE TERMS

A. The terms Employer, Client, Owner are interchangeable and shall mean the presidential palace compound authority

B. The terms ENGINEER is interchangeable and shall mean the nominated the supervision staff.

C. The terms Tenderer, Contractor are interchangeable and shall mean both the firms submitting the tender, and the firm appointed to execute the works.

1.12 WORKING IN PARTNERSHIP

A. Due to the challenging project constraints, the Employer and the ENGINEER are committed to working in partnership with the Contractor. The Contractor is deemed to share and to reciprocate this partnership working.

B. Partnership working shall include, but not be limited to, the sharing of information, knowledge and expertise, early problem identification, joint problem solving, accurate and timely reporting, joint focus on quality, programme and budget.

C. No work to be executed without the direct supervision of the ENGINEER.

***N.B**: No separate payment shall be made on account of "Summary of the Works" to the contractor. Therefore, the cost of "Summary of the Works" shall be deemed to have been included in the price quoted by the contractor for the project.*

Payment Procedures

SECTION 012900
PAYMENT PROCEDURES

Part 1 - GENERAL

1.01 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process applications for payment.

1.02 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by the Engineer and paid for by the Employer.
   1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.

B. Payment-Application Times: Refer to Document II-2 Particular Conditions Clause 60(5).

C. Payment-Application Forms: Use forms provided by the ENGINEER for Applications for Payment.

D. Application Preparation: Complete every entry on the form. Include signature and seal execution by a person authorized to sign legal documents on behalf of the Contractor. The Engineer will return incomplete applications without action.
   1. Work executed and approved shall be scheduled as per the Bills of Quantities with additional columns for quantity executed and value executed.
   2. Include amounts of approved Variation Orders issued prior to the last day of the construction period covered by the application.

E. Transmittals: Submit three (3) signed copies of each Application for Payment to the Engineer by a method ensuring receipt within 24 hours.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the ENGINEER.

F. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following:
   1. List of subcontractors.
   2. Schedule of values.
   3. Contractor’s Construction Schedule.

4. Schedule of products.
5. Submittal schedule.
6. Initial progress report.
7. Report of preconstruction meeting.
8. Certificates of insurance and insurance policies.
9. Performance and advance payment bank guarantee.
10. Initial settlement surveyed and damaged report, if required.
11. Any other document indicated by the Engineer in support of bill.

***N.B**: No separate payment shall be made on account of "Payment Procedures" to the contractor. Therefore, the cost of "Payment Procedures" shall be deemed to have been included in the price quoted by the contractor for the project.*

Project Meetings

SECTION 013110
PROJECT MEETINGS

Part 1 - GENERAL

1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to the following:

1. Preconstruction conferences.
2. Preinstallation conferences.
3. Progress meetings.
4. Coordination meetings.

1.02 PRE-CONSTRUCTION CONFERENCE

A. Pre-Construction Meeting: (kick-off meeting) will be held within seven (7) days of receipt of the order to commence the works and should be attended by the Contractor and his major subcontractors together with the ENGINEER and Employer's Representative. The meeting will be chaired by the ENGINEER.

B. Agenda: The agenda for the pre-construction meeting will be provided to the Contractor by the ENGINEER with a minimum three (3) days prior to the meeting. The agenda will include but not limited to:

1. Contractor's organization arrangements.
2. Channels and procedures for communication.
3. Construction schedule including sequence of critical work.
4. Contract Documents, including distribution of required copies.
5. Processing of shop drawings and other data to be submitted to the ENGINEER for review.
6. Processing of instructions and variations orders.
7. Rules and Regulations governing performance of work.
8. Procedures for safety, first aid, security, quality control, etc.
9. Procedures for reporting and monitoring progress, cost, materials, labor and equipment.
10. Parking availability.
11. Office, work, and storage areas.
12. Equipment deliveries and priorities.
13. Housekeeping.
14. Working hours.

1.03 PRE-INSTALLATION CONFERENCES

A. Conduct a pre-installation conference at the Project Site before each construction activity that requires coordination with other construction.

B. Attendees: The Contractor, Subcontractor, representatives of manufacturers and fabricators or their agents involved in or affected by the installation, and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the ENGINEER of scheduled meeting dates and agenda.
   1. Review the progress of other construction activities and preparations for the particular activity under consideration at each pre-installation conference, including requirements for the following:
      a. Contract Documents.
      b. Authorities Approval.
      c. Options.
      d. Related Variation Orders.
      e. Purchases.
      f. Deliveries
      g. Shop Drawings, Product Data, and quality-control samples.
      h. Review of mock-ups.
      i. Possible conflicts.
      j. Compatibility problems.
      k. Time schedule.
      l. Weather limitations.
      m. Manufacturer's recommendations.
      n. Warranty requirements.
      o. Compatibility of materials.
      p. Acceptability of substrates.
      q. Temporary facilities.
      r. Space and access limitations.
      s. Governing regulations.
      t. Safety.
      u. Inspecting and testing requirements.
      v. Required performance results.
      w. Recording requirements.
      x. Protection.

   2. Record significant discussions and agreements and disagreements of each conference, and the approved schedule. Promptly distribute the record of the meeting to everyone concerned, including the ENGINEER.

   3. Do not proceed with the installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.04 PROGRESS AND COORDINATION MEETINGS

A. Schedule and Coordination Meetings: Job site progress meetings will be held twice each month, or as instructed by the Engineer, to review the Contractor's Construction Schedule and to discuss work progress and coordination. Attendees at this meeting shall include the Employer's Representative and ENGINEER, the Contractor, approved Subcontractors and other direct Contractors as required. The job site progress meetings shall be convened as directed by the ENGINEER. Such meetings will be chaired by the ENGINEER.

B. Pre-Meeting Submittals: Three days before each meeting the Contractor must submit the following information to the ENGINEER:
   1. List of completed activities.
   2. List of current activities, with an estimate of time required for completion.
   3. List of any variations in starting dates and duration of outstanding activities from planned dates and times.
   4. Percentage completion in every activity.
   5. List of activities that the Contractor plans to start during the following period.
   6. Three (3) back-up copies on CDs.
   7. Other information required by the ENGINEER.
   8. Shop drawings submittals status log.
   9. Material submittals status log.
   10. Material Procurement status log.

1.05 SUBCONTRACTOR'S SITE MEETINGS

Hold meetings with appropriate subcontractors and suppliers shortly before main site meetings to facilitate accurate reporting of progress. The ENGINEER may attend such meetings at his discretion.

1.06 TOP TEAM MEETINGS

A. In the spirit of partnership, a top team of four shall be created, which shall consist of two very senior representatives from each of the Employer, the Contractor and the ENGINEER.

B. The Employer shall host top team meetings on site four times per year (months 1, 3, 6 & 11).

C. The top team shall review the project, and shall attempt to amicably defuse conflict and resolve problems. The guiding principle of such meetings shall be the maintenance and advancement of the spirit of partnership and the collaborative approach.

D. Typically minutes of top team meetings will not be taken, but when requested by two or three parties, minutes or a distillation of outcomes will be taken by the Engineer.

1.07 MINUTES OF MEETINGS

A. The proceedings of all meetings (except subcontractor meetings) shall be recorded and minutes distributed by the ENGINEER to all parties present or concerned by not later than the beginning of the next meeting. Such minutes, when accepted, shall be binding upon all parties.

***N.B**: No separate payment shall be made on account of "Project Meetings" to the contractor. Therefore, the cost of "Project Meetings" shall be deemed to have been included in the price quoted by the contractor for the project.*

Electrical Coordinator with Existing Installation

SECTION 013140
ELECTRICAL COORDINATORS WITH EXISTING INSTALLATION

Part 1 - GENERAL

1.01 SUMMARY

A. This section includes administrative and supervisory requirements necessary for coordinating construction operations including but not necessarily limited to the following:
   1. Electrical coordinator with the existing system
   2. Submittals.
   3. Coordination required.
   4. Coordination documents.
   5. Coordination of submittals.
   6. Coordination of substitutions and modifications.
   7. Observation of Work.
   8. Documentation.
   9. Equipment start-up.
   10. Inspection and acceptance of equipment.

1.02 ELECTRICAL WORK COORDINATORS

A. The Contractor shall employ and pay for services of sufficient number of persons having graduation in any electrical engineering discipline with fifteen years' experience in similar projects, engineering, and field coordination for the type of electrical work required for this Project, for the duration of the Work.

1.03 SUBMITTALS FOR REVIEW

A. Submit name and resume with qualifications for Coordinator before starting work.

B. Submit coordination and composite drawings and schedules prior to submitting shop drawings, product data, and samples.

C. All other tasks necessary.

1.04 COORDINATION REQUIRED

A. Coordinate electrical work of the related divisions

B. Coordinate progress schedules, including dates for submittals and for delivery of Products.

C. Conduct meeting among Subcontractors, separate contractors, and others concerned with the Work, to establish and maintain coordination and schedules, and to resolve coordination matters in dispute.

D. Participate in progress meetings. Report on progress of Work to be adjusted under coordination requirements, and any required changes in schedules. Transmit minutes of meetings and reports to concerned parties.

E. All other tasks necessary.

1.05 COORDINATION DOCUMENTS

A. Prepare coordination drawings to organize installation of Products for efficient use of available space, for proper sequence of installation, and to identify potential conflicts.

B. Prepare a master schedule to identify responsibilities under each section of Divisions 1 through 16 (inclusive) of the Contract Documents for activities which directly relate to this work, including submittals and temporary utilities.

C. Identify electrical power characteristics and control wiring required for each item of equipment.

D. Maintain documents for the duration of the Work, recording changes due to site instructions, modifications or adjustments.

E. After ENGINEER review of original and revised documents, reproduce and distribute copies to concerned parties.

F. All other tasks necessary.

1.06 COORDINATION OF SUBMITTALS

A. Review Shop Drawings, Composite Drawings, Product Data, and Samples for compliance with Contract Documents and for coordination with work. Transmit for review, copy reviewed documents to ENGINEER.

B. Check field dimensions and clearances and relationship to available space and anchors.

C. Check compatibility with equipment and Work of other sections, electrical characteristics, and operational control requirements.

D. Coordinate controls, interlocks, wiring of pneumatic switches, and relays.

E. Coordinate wiring and control diagrams.

F. Review the effect of any changes on work of other sections.

G. Verify information and coordinate maintenance of record documents.

H. All other tasks necessary.

1.07 COORDINATION OF SUBSTITUTIONS AND MODIFICATIONS

A. Review proposals and requests from Subcontractors and separate contractors.

B. Verify compliance with Contract Documents and for compatibility with Work and Products of other sections.

C. Submit with recommendation for action.

D. All other tasks necessary.

1.08 OBSERVATION OF WORK

A. Observe Work for compliance with Contract Documents.

B. Maintain a list of observed deficiencies and defects; promptly submit.

1.09 DOCUMENTATION

A. Observe and maintain a record of tests. Record:
   1. Specification section number, Product, and name of Subcontractor.
   2. Name of testing agency and name of inspector.
   3. Name of manufacturer’s representative present.
   4. Date, time, and duration of tests.
   5. Type of tests, and results.
   6. Retesting required.

B. Assemble background documentation for dispute and claim settlement by ENGINEER.

C. Submit copies of documentation to ENGINEER upon request.

D. All other tasks necessary.

1.10 EQUIPMENT START-UP

A. Verify utilities, connections, and controls are complete and equipment is in operation condition as required by Section 017500 “Starting and Adjusting”.

B. Observe star-up and adjustments; record time and date of start-up, and results.

C. Observe equipment demonstrations to Employer; record times and additional information required for operation and maintenance manuals.

D. All other tasks necessary.

1.11 INSPECTION AND ACCEPTANCE OF EQUIPMENT

A. Prior to inspection, verify that equipment is tested, operational, clean, and ready for operation.

B. Assist ENGINEER with review. Prepare list of items to be completed and corrected.

C. All other tasks necessary.

***N.B**: No separate payment shall be made on account of “Mechanical and Electrical Coordinators” to the contractor. Therefore, the cost of “Mechanical and Electrical Coordinators” shall be deemed to have been included in the price quoted by the contractor for the project.*

Scheduling of Construction

SECTION 013260
SCHEDULING OF CONSTRUCTION

Part 1 - GENERAL

1.01 SUMMARY

A. This Section includes administrative and procedural requirements for the critical path method (CPM) of scheduling and reporting progress of the Work.
   1. Refer to the Conditions of Contract for definitions and specific dates of Contract Time.
   2. The work under this clause consists of the scheduling and reporting procedures required to be carried out by the Contractor in conjunction with the progress of the project.

1.02 DEFINITIONS

A. Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the Project.

B. The Construction Programme depicts in general the key activities and milestones and the duration allotted for the same. The Contractor shall be required to plan, perform and coordinate his works with that of other direct Contractors (if any) to meet the time requirements of the project.

C. Construction Schedule(s): The Contractor's developed schedule(s) for execution of the Contract that meets the contract requirements for the performance of this contract and the requirements of the Construction Program.

D. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.

E. Network Diagram: A graphic diagram of a network schedule, showing the activities and activity relationship.

F. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
   1. Critical activities are activities on the critical path.
   2. Predecessor activity is an activity that must be completed before a given activity can be started.

G. Event: An event is the starting or ending point of an activity.

H. Milestone: A key or critical point in time for reference or measurement.

I. Float is the measure of leeway in activity performance. Accumulative float time belongs to the Employer.
   1. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
   2. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.

1.03 CPM SCHEDULE REQUIREMENTS

A. The Contractor shall be responsible for submitting adequate planning data and acceptable cost distribution information for the development and maintenance of the Contractor's cost loaded construction schedule (hereinafter referred to as the "Construction Schedule", all to the approval of the ENGINEER as detailed hereafter.

B. The Contractor shall use a computerized precedence Diagram CPM technique in preparing the Construction Schedule. The software proposed to be used by the Contractor for the CPM is to be approved by the ENGINEER prior to generation of the construction schedule.

C. The Contractor shall develop the Construction schedule demonstrating fulfillment of all contract requirements by cost loading Construction schedule activities with the further construction activities hammocked within the milestone activities. Each milestone activity should represent the related Construction activities hammocked within it by using true connections to reflect the progress on the milestone activity as measured on the hammocked Construction activities. "Summary collection" activities are not accepted as hammocking tools.

D. The Construction schedule shall be updated fortnightly, or when required by the ENGINEER at joint meetings with the Engineer, the Contractor, Subcontractors, and other direct contractors who may be required to attend.

E. Failure of the Contractor to comply with the requirements of this section shall be grounds for recommendation by the ENGINEER that no further progress payment shall be made until the contractor is in compliance.

F. Each revision of the Construction schedule shall be signed by the duly authorized representative of the Contractor and these documents, upon approval by the Engineer, shall thereupon become incorporated in to the contract documents of the project.

1.04 QUALITY ASSURANCE

A. Contractor's Representative: The Contractor shall designate a Scheduling ENGINEER who shall be responsible for the content and development of the Contractor's Construction schedule. This representative shall have direct control and complete authority to act on behalf of the Contractor in fulfilling the requirements of the Construction Schedule requirements and such authority shall not be interrupted throughout the duration of the contract.

B. Qualified Scheduling ENGINEER with ten(10) years experience and in compliance with requirements of Contract Document.

1.05 CONTRACTORS CONSTRUCTION SCHEDULE DEVELOPMENT

A. The contractor shall meet with the ENGINEER to review the scheduling requirement of the project. This review will include the specific requirements of the Contractor regarding restraints and milestones, including the interrelation with other direct contractors, as they relate to the overall Construction programme.

   The Contractor will present restraints, if any, foreseen by himself in the proposed Construction Schedule that may affect the Construction programme.

B. Preliminary Schedule: Submit a preliminary schedule within 14 days of the letter to commence work. The preliminary schedule shall outline activities for the first 60 days of construction. Include a skeleton diagram for the remainder of the Work with the preliminary schedule.
   1. Include each significant Construction activity. Coordinate each activity with other activities. Schedule each Construction activity in proper sequence.
   2. Indicate completion of the Work on the date established for Substantial Completion, unless the Employer agrees otherwise.

C. Within Forty five (45) days of the Date of the letter to commence work the contractor shall submit for the Engineer's approval, the Construction schedule in a bar-chart time-scaled format, to show the sequence and interdependence of activities required for complete performance of all items of work under the contract or portion thereof. Further, this schedule shall reflect the milestones required by the contract documents. In preparing Construction schedule, the contractor shall:

   1. Exercise care to produce a clear, legible, and accurate diagram. Activities related to specific areas of the project shall be grouped on the diagram for ease, understanding, and simplification. The diagram shall show the following for each construction activity, where applicable.
      a. Concise description of the work
      b. Early start and finish dates

c. Number of working days
d. Manpower loading
e. Cost loading
f. Equipment & Machinery Loading
g. Total Float of each activity.

2. Include any trade or material restraints to indicate the movement of trades who are performing major work.
3. Should the Contractor's scheduling software allow open ends to be shown, critical or not critical, then the option of not critical will be adopted.
4. Demonstrate work activities in the Contractor's Construction Schedule to have maximum duration of fifteen (15) days with not more than 2% exceeding these limits, unless otherwise approved by the ENGINEER except as to non construction activities (such as construction work, procurement of materials, delivery of equipment, etc.).
5. The Construction Schedule developed above shall not be changed throughout the duration of the project without getting prior approval from the Engineer.

D. At monthly intervals the Contractor shall submit for the Engineer's approval, a detailed schedule developed from the approved Construction Schedule, covering a period of the next 90 days and relating the contractor's daily work activities.

E. Every two weeks the Contractor shall submit for the Engineer's approval, a detailed schedule covering the next 15 day's activities.

F. The Contractor shall submit the undermentioned supporting data with the submittal of his Construction Schedule and any successive updates and revisions in an approved format by the Engineer.
1. The proposed number of working days per week.
2. The holidays, and other non-working days (except Sunday), including days lost due to diminished productivity during Ramadan, observed during the duration of the contract (by date).
3. The planned number of shifts per day.
4. The number of hours per shift.
5. The planned usage of major construction equipment on the site, on a monthly basis.
6. The planned procurement and delivery of materials on a monthly basis.
7. The average weekly manpower (e.g. number of carpenters, steel fixers, labourers, etc.) usage for each trade to be employed for the works considering activities, duration and production rates.
8. Explanation of all changes in logic in duration, manpower, and equipment.
9. Actual start dates and completion dates of activities already completed.
10. Computer generated text reports listing activities with their early and late start and finish dates sorted by activity number, by early start and by criticality.

11. Productivity rates for all items of work shall identify the basic of production for labours to justify the attached duration of each activity with type and quantity.

G. Failure to include any element of the works required for the performance of the contract shall not excuse the contractor from completing all work required within any applicable completion date of each phase or the whole of the project, notwithstanding the Engineer's approval of the Construction Schedule.

1.06 UPDATING OF CONSTRUCTION SCHEDULE

A. The Contractor shall submit an updated Construction Schedule when the monthly payment is due.

B. Acceptance of the updated construction schedule and all supporting data is contingent upon compliance with all other articles of this clause and any other previous agreements or requirements made with or by the ENGINEER.

1.07 ADJUSTMENT AND REVISIONS

A. The contract duration will be adjusted only in accordance with the provisions of clause 44 (Document II-1) legal clauses and conditions and its amendments in Document II-2 particular conditions. In the event the Contractor requests an adjustment of the contract duration, he shall furnish such justification and supporting data as the ENGINEER may deem necessary for evaluation by the ENGINEER as to whether or not the Contractor will be entitled to an extension of time for completion. Submission of proof based on revised activity, logic, duration, and costs is obligatory with any request.

B. The Contractor shall submit with every request, his revised Construction Schedule whenever the actual field progress of the work does not conform to the latest approved Construction Schedule in force at the time of the alleged delay.

C. The ENGINEER shall, within a reasonable time after receipt of a request for extension of the Contractor will be informed his decisions.

D. When the ENGINEER has not yet made a decision as to any extension of time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Construction programme, and should the Contractor choose to reflect the requested amount of time adjustment in this Construction Schedule, he will do so at his own risk. Such reflection of time adjustment shall only serve the purpose of monitoring the schedule of the works until such time as the Employer has made the final determination as to any extension of time. The Contractor will revise his Construction Schedule thereafter in accordance with the Engineer's decision and act and perform the works accordingly.

E. The Contractor shall submit, as requested by the Engineer, a revision to the Construction Schedule for any of the following reasons:

1. When delays in submittals or deliveries or work stoppage are encountered which make replanning or re-scheduling of the work necessary.
2. When the schedule does not represent the actual execution and progress of the works as being performed in the field.

1.08 SCHEDULING SYSTEM

A. The ENGINEER has established Primavera Project Manager software or Project Manager (for windows) as the standard scheduling application for this project. The latest version of this software shall be used to develop all CPM Construction schedules. The Construction Schedules information and supported data to be provided on data diskettes compatible for use on the Engineer computer system.

1.09 SUBMITTALS

A. All Construction Schedule submittals including revisions and updates, shall consist of the following:
   1. Complete blue line set of diagram from the last approved Construction Schedule marked up in red showing all revisions and changes in accordance with the monthly meeting and signed by the Contractor.
   2. Colour prints of each diagram and with copies of scheduling reports.
   3. Copies of supporting data.
   4. Back-up copies on CDs.
   5. 3 Coloured copies in A0 or A3 size as required and approved by the Engineer.

B. The Contractor has to submit the following reports:
   1. Monthly status report which shows detailed activities, actual start and completion dates, percent complete or remaining duration, and any other requirement by the Engineer.
   2. Material monthly status report which includes material description, unit, material delivered (during the month, accum), material planned (during the month, accum), adjusted by V.O., variance (quantity, %) and any other requirements requested by the Engineer.
   3. Weekly Manpower Report that includes the following in accordance with the approval of the Engineer:
      a. Profession
      b. Average Number
      c. Average working days
      d. Average working hours
      e. Total man-hours
      f. Total man-days.

4. Weekly production report which includes the following:
    a. Description of major work items
    b. Contract quantity
    c. Quantity installed during the week
    d. Quantity installed to-date
    e. Percent of the above

    The number and type of the description of the work items shall be as required by the Engineer.

***N.B**: No separate payment shall be made on account of "Scheduling of Construction" to the contractor. Therefore, the cost of "Scheduling of Construction" shall be deemed to have been included in the price quoted by the contractor for the project.*

Submittal Requirements

SECTION 013290
SUBMITTAL REQUIREMENTS

This section to be read in conjunction with all other related Documents:

Part 1 - GENERAL

1.01 INTRODUCTION

A. Under this section and together with its Tender, the Tenderer shall provide detailed Technical and Financial information as set out herein.

B. Should the Contractor intend to engage any subcontractor for any specialized work or any other work(s), then details of such participation shall be submitted along with the Tender.

1.02 TECHNICAL PROPOSAL

A. The Technical Proposal shall fully detail the Tenderer's approach in dealing with major technical matters associated with the project, in compliance with the requirements of the tender documents shall explain, but not be limited to, the following:
- Understanding of the project.
- Project approach, methodology and deliverables.
- Technical and professional considerations
- Statutory approvals
- Inter-disciplinary coordination
- Project implementation including fast track approach to construction including resources.
- Overall project Management of Construction, Equipment and Furniture Installation, and Operation and Maintenance Works.
- Programming considerations.
- Project risk analysis
- Recommendations for mitigation of major risks

B. Specialized Areas are departments and/or areas within departments, and/or rooms within areas within departments that have only been assigned net areas in the Functional Space Program. All architectural designs and drawings for such areas in this documents are indicative not definitive.

C. It is the responsibility and obligation of the Contractor to fully review, verify the design where needed.

D. The Contractor shall hold and retain sole responsibility and risk due to construction for the impact that Specialized Areas have on the overall Mechanical/Electrical/Plumbing systems, if any, as reflected in the Documents and shall be deemed to have priced for the full ramifications thereof.

1.03 TECHNICAL CAPABILITY

A. The Tenderer shall fully and effectively describe its technical capabilities to undertake the Project. References should be given of the projects of similar nature done and challenges faced during their execution. Technical resources available to meet the project requirements are to be described. The Tenderer's capabilities to make use of latest technologies are to be outlined for material sourcing, procurement and handling, work methods and use of equipment, manpower utilization and overall site administration. The Tenderer must demonstrate technical capability in all technical respects to execute and manage this project in a timely manner and in compliance with the quality expected.

1.04 ORGANIZATION CHART

A. The Tenderer shall submit a complete organization chart for construct, equip, furnish, operate and maintain activities, detailing various staff positions with authorities, responsibilities and job descriptions. This will include the staff of the contractor/sub-contractors, including interaction with the Tenderer’s supervisory and management staff. The local and overseas firms involved in the execution of the project shall be clearly identified with their place/s of work and proportion of work distribution.

1.05 METHODOLOGY

A. The Tenderer shall submit a detailed methodology explaining his approach in fulfilling the Project requirements with regard to the construction of the works, quality control and time control and overall site management to achieve efficient and timely completion of the Project. The methodology shall include all coordination and control systems including, but not limited to, following:
   - Planning schedule Control
   - Document Control
   - Communication Control
   - Client Criteria Compliance
   - Local Authorities Code Compliance
   - Coordination Meeting Strategy
   - Construction Quality Control
   - Financial Plan & Cash Flow
   - Procurement planning & control
   - Furniture, furnishing and equipment implementation strategy

- Project closeout and handover
- Commissioning of works
- Maintenance of works

1.06 WORK PROGRAM FOR EXECUTION

A. A general milestone schedule is provided in Document I. The Tenderer shall prepare and submit with the Technical Proposal a time-based programme to show how the project phases shall be scheduled, in coordination with the projects execution construction strategy and the timely procurement of statutory approvals.

B. The Work Program shall be presented in bar chart format (CPM). It shall identify proposed work tasks or activities for each phase, and show duration of tasks and contacts with governmental agencies.

C. The program must be logically sequenced, adequately detailed to convey a clear understanding of the proposed approach, and consistent with current professional practices and state-of-art analysis.

1.07 SPECIALIST SUB-CONTRACTORS

A. The Tenderer shall provide tentative names of manufacturers, suppliers, companies and subcontractors (if any). List of work done with value of each, shall be submitted. It is expected that highly qualified and experienced parties will be selected and offered for approval by the Engineer. Such approval shall not limit, diminish or in any way transfer the project risk away from the Contractor.

1.08 CURRICULUM VITAE

A. CVs of all senior personnel involved in the construction shall be submitted. The details to be included are Name, Nationality, Qualification and affiliation with Professional Organizations, Names of Employers, Dates of Employment, Position, Details of Experience and Value of each project involved in. All senior positions must have at least 15 years' experience with a minimum of Bachelor's Degree in respective disciplines.

B. Tenderer shall also seek the participation of qualified and experienced personnel and shall follow the requirements of local regulations for employment.

1.09 CONSTRUCTION COST

A. The Tenderer shall incorporate in his Tender all expenses such as Mobilization, Demobilization, labour, Materials, Plant and Equipment, Temporary site facilities, Camp facilities, Transportation, Insurance, Medical facilities, Profit & Overheads.

The Construction Cost details shall be submitted for all elements of Works for which the Tender is submitted as per requirements of Document Bills of Quantities, together with breakdown and price analysis.

B. The Tenderer shall consider in its Cost in particular the following elements: Other Costs: The Tenderer shall include within his Contract price other Costs not specifically catered for elsewhere, some of which are listed below:
   - Testing Costs of materials or any finished works as required by the contract.
   - Removal of improper materials from the site.
   - Remedial of any default works executed by the Contractor,
   - Substitution of any improper materials used at site and rejected by the Engineer.
   - Any extra-over costs due to night or in any other holidays.
   - Any storing facilities, sheds or temporary structures and any Engineering works related thereto.
   - Any safe guarding and security works or facilities.
   - All the expenses related to statutory, insurance policy, Tender Bond, performance Bond, renting storage or offices etc.
   - Shop Drawings and BIM drawing when requested by the Engineer.
   - Defect liabilities / maintenance period.

   The above list is indicative and not exhaustive. The Contractor shall be deemed to have priced for all elements necessary to deliver the project to programme.

1.10 MAINTENANCE DURING DEFECT LIABILITY PERIOD COST

A. The Tenderer shall be responsible for satisfactorily maintaining all the Works under the Contract for a period of one year from the date of Substantial Completion. The Tenderer shall include in his Contract Price all costs related to all types of maintenance of all works of building, equipment, systems, furniture, etc. constructed, installed, tested and commissioned under the contract. This will include Cost of all Material, Spares, Manpower, Equipment, Specialist inspection etc. to keep the works in operational condition.

***N.B**: No separate payment shall be made on account of "Submittal Requirements" to the contractor. Therefore, the cost of "Submittal Requirements" shall be deemed to have been included in the price quoted by the contractor for the project.*

Shop, Composite, Record, As Built Drawings
Product Data and Samples

SECTION 013330
SHOP, COMPOSITE, RECORD, AS BUILT DRAWINGS PRODUCT DATA AND SAMPLES

Part 1 - GENERAL

1.01 SUMMARY

A. This section includes administrative and procedural requirements for submittal of Shop, Composite, Record, and As Built Drawings, Product Data, Samples and other miscellaneous quality control submittals.

B. Shop Drawings include, but are not limited to the following:
   1. Fabrication drawings.
   2. Installation drawings.
   3. Setting diagrams.
   4. Shop work manufacturing instructions.
   5. Templates and patterns.
   6. Schedules
      a. Standard information prepared with specific reference to the project requirements.

C. Product Data include, but are not limited to the following:
   1. Manufacturer's product specifications
   2. Manufacturer's installation instructions.
   3. Standard color charts.
   4. Catalog cuts.
   5. Roughening-in diagrams and templates.
   6. Standard wiring diagrams.
   7. Printed performance curves.
   8. Operational range diagrams.
   9. Mill reports.
   10. Standard product operating and maintenance manuals.

D. Samples include, but are not limited to the following:
   1. Partial Sections of manufactured or fabricated components.
   2. Small cuts or containers of materials.
   3. Complete units of repetitively used materials.
   4. Swatches showing color, texture and pattern.
   5. Color range sets.
   6. Components used for independent inspection and testing.
   7. Field samples.

E. Quality control submittals include, but are not limited to, the following:
   1. Design data.
   2. Certifications.
   3. Manufacturer's instructions.
   4. Manufacturer's field reports.

F. Related Sections: The following sections contain requirements that relate to this section:
   1. Section 013100 - "Project Management and Coordination" specifies requirements governing preparation and submittal of required coordination drawings.
   2. Section 013300 - "Submittal Procedures" specifies requirement for submittal of shop, composite, record, as built drawings, product data and samples.
   3. Section 014500 - "Quality Control" specifies requirements for submittal of inspection and test reports and the erection of mockups.
   4. Section 017220 - "Field Engineering"
   5. Section 017700 - "Closeout Procedures" specifies requirements for submittal of project record documents, including copies of drawings, at project closeout.

1.02 DEFINITIONS

A. "Coordination Drawings" show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.
   1. Preparation of coordination drawings is specified in Section 013100 "Project Management and Coordination" and may include components previously shown in detail on Shop Drawings or Product Data.

B. "Field samples" are full-size physical examples erected on site to illustrate finishes, coatings, or finish materials. Field samples are used to establish the standard by which the work will be judged.

C. "Mockups" are full-size assemblies for review of construction, coordination, testing, or operation, they are not samples.

D. "Shop Drawings" shall establish actual plans, section and details of all construction assembled, manufactured or fabricated items, indicate proper relation to adjoining work, amply design details whether or not included in contract drawings of all work including but not limited to civil, architectural, interiors, mechanical, electrical and site works in proper relation to physical spaces and incorporate minor changes of design or construction to suit actual conditions at no additional cost.

E. "Record Drawings" are a record of the works actually installed as the work progresses including records of all changes and deviations from the Contract Documents.

F. "As-Built Drawings" embody the latest amendment of shop drawings including variations to the Contract to the standards set out in BS 308 part 2.

1.03 SHOP DRAWINGS

A. General: Refer to Section 013300 "Submittal Procedures" for requirement of submitting Contractor's scheduling log.

B. Submit newly prepared information drawn accurately to scale. Do not reproduce Contract Documents or copy standard printed information as the basis of Shop Drawings.
   1. Include the following information on Shop Drawings.
      a. Dimensions using SI units.
      b. Identification of products and materials included.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
   2. Number shop drawings for each section of the works consecutively and the numbering system shall be retained throughout all revisions.
   3. Shop Drawings shall show in detail, materials, dimensions, thickness, assembly, joints, attachments, relation to adjoining work, and all other pertinent data and information. In checking shop drawings, the Contractor shall verify all dimensions and site conditions and shall check and coordinate the shop drawings of any Section or Trade with the requirements of the Sections or Trades of other Contractor's as related thereto, as required for proper and complete installation of the works. The works shall conform to the Contract Drawings or to such other Drawings as may be issued from time to time during the progress of the Works by the Engineer.
   4. The Contractor shall submit composite Shop Drawings coordination of the work of contractors for mechanical, electrical, structural architectural and site work. The composite drawings shall be in sufficient detail to show overall dimensions of ductwork, piping conduit, equipment, fixtures, structural members and related architectural features, and shall show clearance between such work.

5. The Contractor shall attend coordination meetings with his sub-contractors and all other Contractors where work is affected. Following the coordination of the work each subcontractor and each other contractor shall indicate his approval on the reproducible original coordination drawings by signing such drawings. The Contractor shall then distribute a copy of the coordination drawings to each of the subcontractors and other contractors for their respective use. In the event any one of the other contractors employed or to be employed by the Employer is not on board in a timely manner, then coordination is to be done based on design drawings made available by the ENGINEER. The ENGINEER will not accept any shop drawing without this necessary coordination step having been completed.
6. The Contractor shall submit individual shop drawings following the distribution of the coordination drawings that shall bear a stamp indicating that the work has been coordinated with all subcontractors and other Contractors.
7. The Contractor shall prepare composite Shop Drawings and installation layouts, when required, to describe proposed solutions for congested or restricted site conditions. The composite Shop Drawings and site installation layouts shall be coordinated on the site by the Contractor and his subcontractors for the correct coordination and relationship to the work of all other Contractors, based on site conditions.
8. Shop Drawings shall bear the contractor's stamp and signature certifying that they have been coordinated and checked by the Contractor for completeness and compliance with the approved by the Contractor.

1.04 PRODUCT DATA

A. Collect Product Data into a single submittal for each element of construction or system. Mark each copy to show which choices and options are applicable to the project.
   1. Where Product Data includes information on several similar products, some of which are not required for use on the project, mark copies clearly to indicate which products are applicable.
   2. Where Product Data must be specially prepared for required products, materials, or systems because standard printed data are not suitable for use, submit as shop drawings not Product Data.
   3. Include the following information in Product Data.
      a. Manufacturer's printed recommendations.
      b. Compliance with recognized trade association standards.
      c. Compliance with recognized testing agency standards.
      d. Application of testing agency labels and seals.
      e. Notation of dimensions verified by field measurement.
      f. Notation of coordination requirements.

4. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

B. Preliminary Submittal: Submit a preliminary single copy of Product Data where selection of options by the Engineers Representative is required.

1.05 SAMPLES

A. Submit full size, fully fabricated samples, cured and finished in the manner specified, and physically identical with the material or product proposed for use.
   1. Mount, display or package samples in the manner specified to facilitate review of qualities indicated. Prepare samples to match the ENGINEER sample where so indicated. Include the following information.
      a. Generic description of the sample.
      b. Size limitations.
      c. Sample source.
      d. Product name or name of manufacturer.
      e. Compliance with recognized standards.
      f. Compliance with governing regulations.
      g. Availability.
      h. Delivery time.
   2. Submit sample for review of kind, color, pattern and texture for a check of these characteristics with other elements and for a comparison of these characteristics between the submittal and the actual component as delivered and installed.
      a. Submit full range of manufacturers' standard finishes except when more restrictive requirements are specified, indicating colors, textures and patterns for ENGINEER selection.
      b. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented by a sample, submit at least 3 multiple units that show approximate limits of the variations.
      c. Refer to other specification Section for requirements for samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation and similar construction characteristics.
      d. Refer to other specification Sections for sample to be returned to the Contractor for incorporation in the Work. Such samples must be in an undamaged condition at time of use. On the transmittal form, indicate such special requests about disposition of sample submittals.
      e. Samples not incorporated into the Work, or otherwise designed as the Employers property, are the property of the Contractor and shall be removed from the site prior to substantial completion.

B. Field samples specified in individual specification sections are special types of samples. Comply with sample submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

1.06 QUALITY ASSURANCE SUBMITTALS

A. Submit quality control submittals, including design data certifications, manufacturers instructions manufacturers field reports, and other quality control submittal as required under Sections of the Specification.
B. Certifications: Where other Sections of the Specifications require certification that a product, material or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.
    1. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.

1.07 RECORD DRAWING

A. As the work progresses the Contractor shall maintain on a continuous basis a complete and accurate record of all changes and deviations from the Contract Documents which shall be kept at the Site for inspection by the Engineer, his representative, or Employers Representative.

1.08 AS BUILT DRAWINGS

A. The Contractor shall prepare and furnish As-Built Drawings incorporating all updated details from shop drawings and record drawings including all variations to the Contract for the approval of the ENGINEER in accordance with the standards set out in BS 308.

B. The as built drawings shall show the works as executed complete with existing and finished levels and all other things necessary to form an accurate pictorial record of the finished work.

C. Prior to the preparation of as built drawings the Contractor shall obtain the approval of the Engineers representative as to the size of drawings, quality of transparent sheets, method of drawing and other relevant details in accordance with the Contract Documents.

D. All as built drawings shall be numbered and shall have a number series approved by the Engineers representative. A drawing index shall be provided. All negatives of drawings so prepared shall be dated and signed by the Contractor and, when approved, countersigned by the ENGINEER.

E. Any drawings, transparencies etc., produced by the Consultant will be made available to the Contractor and the cost of reproducing shall be borne by the Contractor.

F. All as built drawings, shall be on the ISO "A" series of sheet sizes. As far as possible only SI units of dimensions and the recommended decimal multiples are to be used. The scales must be clearly indicated on the drawings. Dimensioning shall generally be in accordance with BS 308 Part 2.

G. Submit compact discs of all as-built drawings using the latest format of AutoCAD as with stipulated in the Section 017880 – Project Record Documents".

1.09 COMPOSITE DRAWINGS

A. The Contractor shall prepare and furnish full composite drawings in order to avoid clashes of services, structure and finishes etc.
B. The Contractor shall be wholly responsible and liable for full coordination of all drawn information, and for all rectification measures and/or work necessary to remedy any short coming in coordination and any resultant clashes.

***N.B**: No separate payment shall be made on account of "Shop, Composite, Record, As Built Drawings Product Data and Samples" to the contractor. Therefore, the cost of "Shop, Composite, Record, As Built Drawings Product Data and Samples" shall be deemed to have been included in the price quoted by the contractor for the project.*

Temporary Barriers and Enclosures

SECTION 015600
TEMPORARY BARRIERS AND ENCLOSURES

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Provision of safety measures at the specified location around all work areas, work includes the following:
   1. Installation
   2. Maintenance.
   3. Removal.

1.02 SYSTEM DESCRIPTION

A. The site is already completely fenced. Safety gates 2.50 m high (two numbers) of braced construction will be installed to provide entry/exit to the site. The gates will be manned round the clock to prevent unauthorized persons violating the works site area.

B. The safety gates should be positioned in locations approved by the Client/Engineer.

C. Temporary access for heavy vehicles shall be coordinated with the Presidential Guard and facility security. Submit route plans, delivery time windows, escort requirements, and day-of notifications. Provide traffic marshals, wheel-wash, spill-control kits, and maintain clear emergency egress at all times.

1.03 SUBMITTALS

A. Submit to the ENGINEER shop drawings under provisions of Section 013330.

B. Show layout, details of construction, foundations, sizes, and grades of members.

C. Obtain ENGINEER approval and approvals of Client.

1.04 QUALITY ASSURANCE

A. Design in accordance with statutory requirements and instructions of the ENGINEER .

B. Finish: Adequate to withstand weathering, fading, and chipping for duration of project.

Part 2 - PRODUCTS

2.01 MATERIALS

A. Materials and products specified herein shall take precedence over the safety programme Section 015000.

B. Post and Gate Construction: Galvanised steel and structurally sound.

C. Gate Hardware: Secure locks and bolts to all gates.

D. Paint and Primers: Exterior quality, two coats. Colors designated by ENGINEER.

Part 3 - EXECUTION

3.01 INSTALLATION

A. Install safety gates complete before areas of work may commence.

B. Erect safety gates in approved location as approved on Site Layout submitted by Contractor in accordance with Section 013300.

C. Erect gate posts and framing on secure foundation, rigidly braced and framed to resist wind loadings.

D. Paint sight-exposed surfaces of safety fence, posts and gates.

3.02 MAINTENANCE

A. Maintain safety gates including cleaning and repairing deterioration and damages as required by the ENGINEER at no extra cost.

B. Repaint as necessary and whenever instructed by the ENGINEER .

3.03 REMOVAL

A. Remove safety measures at completion of project after getting permission from the ENGINEER .

***N.B**: No separate payment shall be made on account of "Temporary Barriers and Enclosures" to the contractor. Therefore, the cost of "Temporary Barriers and Enclosures" shall be deemed to have been included in the price quoted by the contractor for the project.*

Product Substitution Procedures

SECTION 016300
PRODUCT SUBSTITUTION PROCEDURES

Part 1 - GENERAL

1.01 SUMMARY

A. This section includes administrative and procedural requirements for handling requests for alternatives and substitutions made after award of the Contract.

B. Related Sections: The following sections contain requirements that relate to this section:
   1. Section 014220 - “Reference Standards” specifies the applicability of industry standards to products specified.
   2. Section 013300 - “Submittal Procedures” specifies requirements for submitting the Contractor’s Construction Schedule and the Submittal Schedule.
   3. Section 016100 - “Basic Product Requirement” specifies requirements governing the Contractor’s selection of products and product options.

1.02 DEFINITIONS

A. The term “product” shall mean any material including proprietary goods, equipment and manufactured items.

B. Alternative products: References herein to “approved equal” or similar terms shall mean that the approval of the Engineer is required to any alternative product proposed by the Contractor. The Contractor’s freedom, however, to propose alternatives for the Engineer’s review and approval shall not be limited to those products in respect of which the term “approved equal” or similar has been used in the Contract Documents except where it is specifically stated otherwise in individual specification sections. The Contractor in accordance with the above may propose alternatives to any specified products provided such alternatives are equal or better in all respects to the quality, durability and performance characteristics of the specified product.

C. Substitute products: If the Contractor is unable to obtain the specified product in spite of his best endeavors, and if he is unable to find and propose a suitable equal or better alternative he may propose a substitute for the Engineer’s review and approval, which substitute shall be similar to, and as near as possible equal or better than the quality, durability and performance characteristics of the specified product. A substitute product will only be considered if the Contractor has proved to the Engineer’s reasonable satisfaction that the specified product is unobtainable.

1.03 SUBMITTALS

A. Alternative and Substitution Submittals:
   1. Submit 3 copies of each request for alternative and substitutions for consideration.
   2. Identify the product or the fabrication or installation method to be replaced in each request. Include related specification section and drawing numbers.
   3. Provide complete documentation showing compliance with the requirements for alternatives and substitutions and the following information, as appropriate:
      a. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Employer and separate contractors that will be necessary to accommodate the proposed alternative or substitution.
      b. A detailed comparison of significant qualities of the proposed alternative or substitution with those of the work specified. Significant qualities may include elements, such as performance, weight, size, durability and visual effect.
      c. Product data, including drawings and descriptions of products and fabrication and installation procedures.
      d. Samples, where applicable or requested.
      e. A statement indicating the alternatives and substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the alternative or substitution. Indicate the effect of the proposed alternative of substitution on overall Contract Time.
      f. Cost information, including a proposal of the net reduction, if any in the Contract Sum. Additional costs are not accepted. This should be substantiated by comparative quotations (CIF) with complete rate breakdown for both the proposed alternative/substitute item and the specified item.
      g. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the alternative and substitution to perform adequately.
      h. Warranty: Reimbursement for review and redesign services.

B. Engineer's approval of alternatives and substitutes: The approval of any alternative or substitute product shall be solely at the discretion of the Engineer and such approval shall in no way relieve the Contractor of any of his liabilities and obligations under the Contract. The burden of proof in satisfying the Engineer as to the suitability of any proposed alternative or substitute product shall rest with the Contractor, and the Engineer may request and the Contractor shall provide such supporting data, carryout such tests, etc., as the Engineer may reasonably require in order to satisfy himself as to such suitability.

   Any delays or extra costs suffered by the Contractor because of his failure to propose alternatives in a timely manner so as to allow the Engineer reasonable time to review, or because of rejection of alternatives or substitutes found by the Engineer to be unsuitable, shall be the responsibility of the Contractor and he

shall not be entitled to additional payment nor extra time for completion in this respect.

C. Cost effect in approving alternatives and substitutes: Should any alternative or substitute product be approved by the Engineer, any net increase in cost over and above the specified product shall be borne by the Contractor and, any net saving in cost shall be to the benefit of the Employer.

Part 2 - PRODUCTS

2.01 ALTERNATIVE AND SUBSTITUTIONS

A. The specifying of manufacturers or their products by name, trade name, catalogue number, etc., shall not act to relieve the Contractor either from his responsibility to meet other specification requirements, or from his responsibility to make material submittals for approval.

B. Alternative or substitute products where permitted and approved, must conform to the Engineer's designed space requirements. Any such alternative or substitute product that does not meet such space requirements, whether approved or not, shall be replaced at the Contractor's expense and any modification of replaced systems thereby arising shall also be made at his expense.

***N.B**: No separate payment shall be made on account of "Product Substitution Procedures" to the contractor. Therefore, the cost of "Product Substitution Procedures" shall be deemed to have been included in the price quoted by the contractor for the project.*

Field Engineering

SECTION 017220
FIELD ENGINEERING

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Administrative and procedural requirements for field Engineering Services in accordance with the requirements of the contract documents. Work includes:
   1. Land survey work.
   2. Civil engineering services.
   3. Structural engineering services.

B. Related Sections: The following sections contain requirements that relate to this section:
   1. Section 011100 - Summary of Works
   2. Section 013300 - Submittal Procedures
   3. Section 013330 - Shop, Record, As-Built Drawings, Product Data and Samples
   4. Section 017880 - Project Record Documents

1.02 REFERENCES

A. British Standards Institute:
   1. BS 5606 - Code of Practice for Accuracy in building.
   2. Or any other reference approved similar.

1.03 SUBMITTALS

A. Submit name and resume with qualifications for Land Surveyor before starting survey work.

B. On request, submit documentation verifying accuracy of survey work.

C. Submit a copy of registered site drawing and a declaration signed by the Land Surveyor that the elevations and locations of the work are in conformance with the Contract Documents.

1.04 QUALITY ASSURANCE

A. Qualified Land Surveyor with ten (10) years' experience and in compliance with requirements of Contract Document.

B. Regulatory Requirements: The Contractor shall be responsible to coordinate with the survey of local authorities to identify the site control points, bench marks and related approvals.

1.05 PROJECT RECORD DOCUMENTS

A. Maintain complete, accurate log of control and survey work as it progresses.

B. On completion of foundation walls and major site improvements, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and site work.

C. Submit Record Documents under provisions of Section 013300 “Submittal Procedures”.

Part 2 - EXECUTION

2.01 INSPECTION

A. Before ordering any material or doing any work, verify all measurements and be responsible for their correctness. No extra charge or compensation will be allowed on account of difference between actual measurements and the dimensions given in the Contract Documents. Any difference which may be found shall be submitted to the Engineer in writing for consideration before proceeding with the works.

2.02 GENERAL

A. Site Bench Marks shall be accurately and safely established, protected, maintained and cleared away upon completion of works or when no longer required all to the satisfaction of the Engineer. Such Bench Marks shall be related to the nearest permanent Bench mark fixed by the survey of local authorities.

B. Prepare a plan detailing the location of the Bench Marks and keep up to date throughout the operational period of the Contract. Reproducible copies of the plan so prepared shall be supplied to the Engineer, as and when he may require.

C. The Engineer reserves the right to order levels to be taken at any time considered necessary for the full and proper supervision and measurement of the works especially for excavation works.

D. Before the works or any parts thereof are commenced the Contractor and the Engineer shall together survey and take levels of the Site of the works and agree upon all particulars on which setting out of the works shall be based.

E. Such levels shall be related to the Bench marks of aforesaid and plotted by the Contractor and after agreement of the drawings shall be signed by the Engineer and the Contractor, and shall form the basis of setting out of the Works.

F. Failing such surveys and agreements being prepared and/or signed by the Contractor, the surveys of the Engineer shall be final and binding upon both parties.

G. The Contractor shall plot these levels and after they have been signed by the Engineer and the Contractor, the original with three (3) copies of it will be submitted to the Engineer and the Contractor shall bear the cost.

2.03 SURVEY REFERENCE POINTS

A. Protect survey control points prior to starting site work; preserve permanent reference points during construction. Make no changes without prior written notice to Engineer.

B. Promptly report to Engineer the loss or destruction of any reference point or relocation required because of changes in grades or other reasons. Replace dislocated survey control points based on original survey control.

2.04 SURVEY REQUIREMENTS

A. Establish, if required by Engineer, other permanent bench marks on site, referenced to establish control points. Record locations, with horizontal and vertical data, on Project Record Documents.

B. Establish lines and levels, locate and lay out by instrumentation and similar appropriate means:
   1. Site improvements, including pavements; stakes for grading, fill and topsoil placement and utility locations, slopes, and invert elevations.
   2. Grid or axis for structures.
   3. Building foundations, column locations, ground floor elevations, and the like.

C. Periodically verify layouts by same means.

D. The Contractor shall provide for the use of the Engineer and his staff, all necessary survey instruments, including a modern the odolite and stand, modern level, level staff, load lines, 30 meter steel tapes and other equipment and labor and attendance which the Engineer may require for checking and setting out and marking the Works. The survey instruments shall remain the property of the Contractor.

E. Coordinates for all completed as-built construction shall be coordinated, registered and filed.

2.05 LAYING OUT

A. Lay out the Works using methods and necessary instruments described in BS 5606 “Code of Practice for Accuracy in Building” section 5 and within the following permissible deviations:
   1. Linear dimensions: Plus or Minus 5mm (1/15,000).
   2. Angular dimensions: + or -2 seconds.
   3. Verticality: Storey height: Plus or minus 20mm building height only

4. Levels:
   - Top of foundations: Plus 5mm or minus 20mm
   - Floor slabs to datum: Plus or minus 10mm
   - Floor slabs to 5M straight edge Plus or minus 5mm

B. Obtain the true and accurate building lines from the Capital Development Authority and lay out the Works as shown on the Drawings.

C. Submit details of methods and equipment to be used in laying out the Works.

D. Check the levels and dimensions of the Site against those shown on the Drawings and record the results on a copy of the Drawings. Notify the Engineer in writing of any discrepancies and obtain instructions before proceeding.

E. Inform the Engineer when overall laying out is complete.

F. Arrange the setting out, erection, juxta-position of components and application of finishes (working within the practical limits of the design and Specification) to ensure that there is a satisfactory fit at junctions and that the finished work has a well aligned, true and regular appearance.

G. Wherever satisfactory accuracy, fit and/or appearance of the work are likely to be critical or difficult to achieve, obtain approval of proposals or of the appearance of the relevant aspects of the partially finished work as early as possible.

H. Work which fails to meet the specified levels of accuracy must not be rectified without approval.

I. Submit proposals for such rectification and meet all costs arising, including effects on other work.

J. Allow for the possibility that approval will not be given, necessitating removal and replacement of the work.

***N.B**: No separate payment shall be made on account of "Field Engineering" to the contractor. Therefore, the cost of "Field Engineering" shall be deemed to have been included in the price quoted by the contractor for the project.*

Final Cleaning

SECTION 017410
FINAL CLEANING

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Final cleaning of the project works.

1.02 DESCRIPTION

A. Execute final cleaning immediately prior to inspection for Substantial Completion of the works.

1.03 QUALITY ASSURANCE

A. Final cleaning shall be under taken only by an industrial cleaning specialist subcontractor with five (5) years' experience in similar types of work.

Part 2 - PRODUCTS

2.01 CLEANING MATERIALS

A. Use materials which will not create hazards to health or property, and which will not damage surfaces.

B. Use only materials and methods recommended by manufacturer of material being cleaned. Submit to ENGINEER for approval.

Part 3 - EXECUTION

3.01 FINAL CLEANING

Cleaning operations shall include, but not be limited to the following:

A. In addition to removal of debris and cleaning operations specified in other sections, clean interior and exterior exposed-to-view surfaces.

B. Remove temporary protection, wrappings, markings and labels not required to remain.

C. Clean finishes free of dust, stains, films, paint and mortar splashes and other foreign substances.

D. Clean transparent and glossy materials inside and out to a polished condition; remove foreign substances. Polish reflective surfaces to a clear shine.

E. Clean, scrub, damp mop or wax and polish resilient and hard surfaced floors as specified.

F. Clean surfaces of equipment; remove excess lubrication.

G. Clean and polish plumbing fixtures and equipment to a sanitary condition.

H. Clean permanent filters of ventilating equipment and replace disposable filters when units have been operated during construction; in addition, clean ducts, blowers, and coils when units have been operated without filters during construction.

I. Clean light fixtures and lamps.

J. Cleaning shall be continued till the handing over of the project to the Employer.

K. Remove waste, foreign matter, and debris from roofs, gutters, area ways, and drainage systems.

L. Remove waste, debris, and surplus materials from site. Clean grounds; remove stains, spills, and foreign substances from paved areas and sweep clean. Rake clean other exterior surfaces.

3.02 DEEP CLEANING

Just prior to handover execute a full professional deep clean of the whole project.

A. Must be executed to Ministry of Health standard and guidelines.

B. Must be executed by a professional deep cleaning specialist subcontractor with a minimum of 5 years' experience of executing deep cleans.

C. The specialist subcontractor must be approved by the Engineer.

***N.B**: No separate payment shall be made on account of "Final Cleaning" to the contractor. Therefore, the cost of "Final Cleaning" shall be deemed to have been included in the price quoted by the contractor for the project.*

Operation and Maintenance Data

SECTION 018300
OPERATIONAL MAINTENANCE DATA

Part 1 - GENERAL

1.01 SUMMARY

A. A. Section Includes:
   1. Format and content of manuals.
   2. Instruction of Employer's personnel.
   3. Schedule of submittals.

B. B. Related Sections:
   1. Section 013300 - Submittal Procedures
   2. Section 014500 - Quality Control
   3. Section 016100 - Basic Product Requirements
   4. Section 017700 - Closeout Procedures
   5. Section 013290 – Submittal Requirement
   6. Individual Specifications Sections: Specific requirements for operational maintenance data.

1.02 QUALITY ASSURANCE

A. Prepare instructions and data by approved personnel experienced in operational maintenance of described products.

1.03 FORMAT

A. Prepare data in the form of an instruction manual.

B. Binders: Commercial quality, size A4 three-ring binders with hardback, cleanable, plastic covers; 50mm maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

C. Cover: Identify each binder with typed or printed title "Operational Maintenance Instructions": list title of Project and identify subject matter of contents.

D. Arrange content by systems under division and section numbers and sequence according to Index of Document III-2 - Particular Specifications.

E. Provide tabbed flyleaf for each separate product and system, with typed description of product and major component parts of equipment.

F. Text: Manufacturer's printed data, or typewritten data.

G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.04 CONTENTS, EACH VOLUME

A. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Engineer and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

B. For Each Product or system: List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

C. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.

D. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

E. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure.

F. Warranties and Bonds: Bind in copy of each.

G. Operational Maintenance Manual should include:
   1. Register/Contents
   2. Description of each system
   3. Schedule of Material
   4. Factory Inspection and Test Certificates
   5. Testing & Commissioning Reports
   6. Guarantees/Warrantees
   7. Operation Instruction/System Startup and Shutdown Procedure
   8. Maintenance Instructions/Planned Preventive Maintenance Instruction and Program
   9. Break Down Maintenance Procedure
   10. Spare Parts
   11. As Built Drawings

1.05 MANUAL FOR MATERIALS AND FINISHES

A. Building Products, Applied Materials, and Finishes: include product data, with catalog number, size, composition, and color and texture designations. Provide information for reordering custom manufactured products.

B. Instructions for Care and Maintenance: Include manufacturer’s recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture-protection and Weather-exposed Products: include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional Requirements: As specified in individual specifications sections.

E. Provide a listing in Table of Contents for design data, with tabbed flysheet and space for insertion of data.

1.06 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Each item of equipment and each system: Include description of unit or system, and component parts. Give function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

B. Panel board circuit directories: Provide electrical service characteristics, controls, and communications.

C. Include as-installed color coded wiring diagrams.

D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut down, and emergency instructions. Include summer, winter, and any special operating instructions.

E. Maintenance requirements: Include routine procedures and guide for trouble shooting; disassembly, repair, and reassemble instructions; and alignment, adjusting, balancing, and checking instructions. Provide maintenance instruction/planned preventive maintenance instruction, program and breakdown maintenance procedure.

F. Provide servicing and lubrication schedule, and list of lubricants required.

G. Include manufacturer’s printed operation and maintenance instructions.

H. Include sequence of operation by controls manufacturer.

I. Provide original manufacturer’s parts list, illustrations, assembly drawings, and diagrams required for maintenance.

J. Provide as-installed control diagrams by controls manufacturer.

K. Provide Contractor’s coordination drawings, with as installed color coded piping diagrams.

L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

M. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

N. Include description of each system.

O. Include test, balancing and commissioning report.

P. Include factory inspection and test certificate.

Q. Additional Requirements: As specified in individual Specifications sections.

R. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

S. Photocopies of Warranties.

1.07 SUBMITTALS

A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.

B. For equipment or component parts of equipment put into service during construction and operated by Employer, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes in final form 15 days prior to request for Substantial Completion. Copy will be returned after Substantial Completion with Engineer's comments. Revise content of documents as required prior to final submittal.

D. Submit four copies of revised volumes of data in final form within ten days after Substantial Completion.

Structure Demolition

SECTION 024116
STRUCTURE DEMOLITION

Part 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Demolition of existing asphalt paving, curbstones, pavers and other site facilities (if any).
   2. Demolition, removal and rerouting of existing services.
   3. Demolish the existing construction only to the extent required by the new construction and as indicated.

1.02 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Employer's property.

B. Remove and Salvage: Items indicated to be removed and salvaged remain the Employer's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Employer's designated storage area which shall be within 5 km off site.

C. Existing to Remain: Protect construction indicated to remain against damage and soiling during demolition. When permitted by the Engineer, items may be removed to a suitable, protected storage location during demolition and then cleaned and reinstalled in their original locations.

1.03 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, or otherwise indicated to remain the Employer's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

1.04 SUBMITTALS

A. General: Submit each item in this Article in accordance with the requirements of Contract Documents, for information only, unless otherwise indicated.

B. Proposed dust-control measures.

C. Proposed noise-control measures.

D. Schedule of demolition activities indicating the following:
   1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity.
   2. Dates for shutoff, capping, and continuation of utility services.

E. Inventory of items to be removed and salvaged.

F. Inventory of items to be removed by Employer.

G. Photographs, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by demolition operations.

H. Record drawings at Project closeout according to Division 1 Section "Contract Closeout."
   1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

1.05 QUALITY ASSURANCE

A. All demolishing and excavation works should be done by an experienced sub-contractors.

Part 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Requirements for satisfactory soil materials as specified.
   1. Obtain approved borrow soil materials off-site when sufficient satisfactory soil materials are not available on-site.

Part 3 - EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

D. Perform surveys as the Work progresses to detect hazards resulting from demolition activities.

3.02 UTILITY SERVICES

A. Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.
   1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Employer and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Employer and to governing authorities.
      a. Provide not less than 72 hours' notice to Employer if shutdown of service is required during changeover.

B. Utility Requirements: Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.03 PREPARATION

A. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, acids, flammables, or other dangerous materials before proceeding with demolition operations.

B. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area.
   1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
   2. Protect existing site improvements, appurtenances, and landscaping to remain.
   3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

3.04 EXPLOSIVES

A. Explosives: Use of explosives will not be permitted.

3.05 POLLUTION CONTROLS

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.

C. Clean adjacent buildings and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before start of demolition.

3.06 DEMOLITION

A. General: Demolish the existing construction only to the extend required by new construction and as indicated.

B. Damages: Promptly repair damages to adjacent facilities caused by demolition operations.

3.07 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials except those indicated to be salvaged or reinstalled. Do not allow demolished materials to accumulate on-site.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Employer's property and legally dispose of them.

D. Storage or sale of removed items or materials on-site will not be permitted.

3.08 PROTECTION

A. Provide, erect and maintain all, lights, barriers, warning signs and all other items as required for the proper protection of the workman engaged in the demolition operations.

B. Do not close or obstruct any services or public utilities without permission. Conduct operations with minimum traffic interference.

Site Preparation

SECTION 024200
SITE PREPARATION

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Site preparation work in accordance with the requirements of the Contract Documents. Work includes:
   1. Clear actual building site of trees, plant life and grass.
   2. Remove complete root system of trees and shrubs.
   3. Remove surface debris.
   4. Remove all existing concrete structures and temporary structures.
   5. Divert utility and other services in compliance with regulations.
   6. Filling necessary due to demolition by other Contractors.
   7. Disposal of removed materials away from site and in a legal manner in full compliance with local authorities' rules and regulations.

B. Related Sections
   1. Section 015000 – Temporary Facilities and Controls

1.02 QUALITY ASSURANCE

A. Conform to local codes and regulations for disposal of debris.

B. Obtain approval (from authorities having jurisdiction) for erection of site fence and sign boards.

1.03 SUBMITTALS

A. Site Conditions: Submit to Engineer for review photographs or videotape sufficiently detailed existing conditions of trees and planting, adjoining construction and any other relevant details.

1.04 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, street walks and other adjacent occupied or used facilities during site clearing operations.

B. Provide alternative routes around closed or obstructed traffic way if required by authorities having jurisdiction.

Part 2 - PRODUCTS - Not used

Part 3 - EXECUTION

3.01 CLEARING

A. Access: Clear areas required for access to site and execution of work.

B. Undergrowth:
   1. Clear site of bushes, shrub and undergrowth without disturbing subsoil.
   2. Grub out and dispose of large roots.

C. Existing Services:
   1. Check with the various Governmental and local authorities for any existing services on site.
   2. Seal off drain ends.
   3. Comply with regulations and obtain necessary permits.
   4. When necessary divert all services still in use and provide all temporary works to maintain in full functional order.

D. Waterways:
   1. Temporarily divert as necessary all field drains and other waterways encountered during the excavations and:
      a. If possible, reinstate on completion.
      b. If not possible to reinstate, obtain instructions.

E. Demolition: Remove existing concrete pavings, pipes, permanent or temporary structures, etc. Dispose of materials, away from site and in a legal manner.

F. Filling: Fill and compact in layers in accordance with specification, all voids caused due to demolition by other Contractors.

3.02 PROTECTION

A. Protect bench marks from damage or displacement.

B. Maintain designated site Access on the Site Layout Organization Plan(s) for vehicle and pedestrian traffic.

C. Protect existing services facilities (if any) in accordance with requirements of relevant authorities.

Earth Moving

SECTION 024250
EARTH MOVING

Part 1 - GENERAL

1.01 SUMMARY

A. General: Perform earthwork necessary to complete all site clearing excavating, filling and grading including preparation of sub grade for slabs and pavement as shown on the drawings or inferable there from and/or as specified in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   1. Excavation for raft foundation
   2. Excavation for isolated, continuous footings
   3. Excavation for paved areas and kerbs
   4. Trench excavation
   5. Back filling for buildings and structure
   6. Filling grading and compaction
   7. Testing
   8. Clearing away surplus excavated materials

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. ASTM C 33 : “Specification for Concrete Aggregates”
   2. ASTM D 422 : “Method for Particle - size Analysis
   3. ASTM D 1556 : “Test Method for Density of Soil in place by the Sand-cone Method”
   4. ASTM D 1557 : “Test Methods for Moisture - Density Relations of Soils and Soil Aggregate Mixtures”
   5. ASTM D 2167 : “Test Method for Density of Soil in place by the Rubber-Balloon Method”
   6. ASTM D 4318 : “Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils”

B. Occupational Safety and Health Administration (OSHA):
   1. Part 1926. Subpart P : "Excavation, Trenching and Shoring, Construction Safety and Health Regulations".

1.03 SUBMITTALS

A. Submit with the method statement at time of Tender information regarding the procedures intended to be followed with regard to excavation, and dewatering over the area of the site and particularly with regard to the existing adjacent buildings and public roads and walkways, for the review and approval of the Engineer.

B. Submit full details, shop drawings and calculations of all these procedures for the review and approval of the Engineer before commencing the excavations and dewatering.

C. Test Reports:
   1. Submit the following reports to Engineer from the testing laboratory:
      a. Report and Certification of granular fill and drainage fill.
      b. Test reports on borrow materials.
      c. Report on the actual unconfined compressive strength or results of plate bearing test of each strata tested.
      d. Core optimum moisture-maximum density curve for each type of soil encountered.
      e. Field density test reports.

1.04 QUALITY ASSURANCE

A. Specialist Subcontractor for the works shall meet the requirements as specified in the Documents I and II.

B. Regulatory Requirements:
   1. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

C. Testing and Inspection:
   1. Submit proposed name of independent Testing Agency for the approval of the Engineer. Employ, at no extra cost to the Employer, the approved Testing Agency to perform all tests and submit reports specified in this Section. Approval may be withdrawn at the discretion of the Engineer and an alternative Testing Agency approved.
   2. The independent Testing Agency shall be responsible for conducting and interpreting the tests, shall state in each report whether or not the test specimens comply with all requirements of the Contract Documents and shall specifically note any deviations there from.

1.05 PROJECT CONDITIONS

A. Examine the Site, record of test borings, and the subsurface exploration reports to determine all conditions under which the Work will be performed.
   1. A soil investigation has been carried out on behalf of the Employer by Berkeley and a copy of the report is included with the Tender Documents. This report is provided “for information only” and will not be considered to be part of the Tender or Contract Documents. The Contractor should do his own soil investigation and cost is included within the cost of the items in the project.
   2. Obstructions, of which no records are available, may be encountered. Make enquiries as to the nature of the ground and the sub-soil conditions and formulate conclusions as to the extent of such obstruction and remove all materials of any nature to the design sub grades indicated or hereinafter specified.

B. Pumping and Drainage: Excavate areas so as to afford adequate drainage. Control grading to prevent water running into the excavated areas. Until the work is completed, remove water that may interfere with the proper performance of the work or cause ponding.

C. Perform all work in such manner as to ensure the safety of the Works, the public and adjoining sites and so as to cause as little inconvenience as possible to the public and adjoining Owners, and allow in the Tender for all necessary precautions to that end.

D. Use of Explosives: Use of explosives is not permitted.

Part 2 - PRODUCTS

2.01 MATERIALS

A. Structural Fill

1. Sound, clean, durable, granular materials free from deleterious matter and in accordance with the following gradations:

ASTM Sieve Size	Total % Passing by Weight
51mm	100
38mm	70-100
25mm	55-85
19mm	50-80
9mm	40-70
No. 4	30-60
No. 10	20-50
No. 40	10-30
No. 200	5-15

2. Gradations in the table above represent the limits which shall determine suitability of aggregate for use from the sources of supply.
3. Structural fill is classified as well-graded granular soils - Group 1 (non-plastic soils with a uniformity coefficient exceeding 10).
4. Use structural fill under concrete slabs, sidewalks, paving, under utility pipes, and at other soil bearing situations for fill within 300 mm measured horizontally of foundation walls, retaining walls, edges of footings and other below-grade vertical surfaces as approved by the Engineer, except where drainage fill is indicated or specified.
5. If sufficient structural fill material is not available from site excavations under this Contract, then additional fill, suitable for use, shall be brought to the Site from other approved sources. Both excavated material from the Site for use as structural fill and material brought to the Site for use as structural fill, shall meet the above requirements.

B. Ordinary Fill

1. Natural soil, well-graded and free from all organic, weak, compressible and expansive materials, (such as high plastic clays) and also free of materials subject to decay or decomposition and shall contain no stone larger than 150 mm in maximum dimension.
2. Ordinary fill is classified as uniformly graded material - Group 2 (non-plastic soils with a uniformity coefficient of 10 or less).
3. Use ordinary fill for spot reinforcement, general grading and backfilling except in areas where structural or drainage fill is required.
4. If sufficient ordinary fill material is not available from site excavations under this Contract, then additional fill, suitable for use, shall be brought to the Site from other sources. Both excavated material from the Site for use as ordinary fill and material brought to the Site for use as ordinary fill, shall meet the above requirements.

C. Drainage Fill
   1. Unless otherwise specified, drainage fill material shall be fine aggregate, clean, well graded, free-draining sand, complying with ASTM C 33.
   2. Drainage fill material shall be placed where called for in the Specifications or Drawings

D. Sand Fill
   1. Sand shall consist of natural sand, crushed stone sand or crushed gravel sand, or combination of any of these. They shall be hard, durable, clean, non-plastic and free from adherent coatings, such as clay and other organic impurities.
   2. Sand shall not have more than 10 percent passing the number 200 sieve and maximum size 5 mm.

E. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel in accordance with ASTM D448 size 57 with 100% passing and 37.5mm sieve shall be 0 to 5% passing.

F. Fine Graded Granular Material: Clean mixture of crushed stone or crushed gravel or natural sand as ASTM D448 with 100% passing; 9.5mm sieve shall be 10 to 30% passing.

G. Impervious Fill: Clayed gravel and sand mixture capable of compacting to a dense state.

2.02 ACCESSORIES

A. Warning Type: Acid and alkali-resistant polyethylene warning tape manufactured for marking and identifying underground utilities 150mm wide and 4 mils (0.1mm) thick continuously inscribed with a description of utility.

B. Detectable Warning Tape: Acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 150mm wide and 4 mils (0.1mm) thick, continuously inscribed with a description of utility with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 750mm deep.

C. Colored as follows:
   1. Red: Electric
   2. Yellow: Gas, oil, steam and dangerous materials
   3. Orange: Telephone and other communications
   4. Blue: Water system

Part 3 - EXECUTION

3.01 EXCAVATION

A. General: Excavate to lines and elevations as required. Make excavations sufficiently large to permit placing and removal of forms, installation of waterproofing, utilities and other work below grade and for inspection thereof. Provide required temporary construction slopes atsides of the excavation as necessary.

B. Unclassified Excavation: Excavation shall be unclassified and shall comprise and include the satisfactory removal and disposal of all materials encountered regardless of the nature of the materials and shall be understood to include rock, gatch, shale, earth, hardpan, fill, foundations, piping and debris of any other unforeseen items.

C. Excavation for Raft Foundation, Isolated and Continuous Footings
   1. Sub grades: Sub grades below blinding concrete for raft foundation, isolated and continuous footings and sub grades below any other foundations shall be approved by the Engineer before proceeding with the construction. Bottoms of blinding concrete below the raft foundation, isolated and continuous footings shall be founded on firm soil at elevations indicated on Drawings and as approved by the Engineer. Sub grades to receive raft foundation, isolated and continuous footings shall be level and free of loose rock, dirt, debris and standing water prior to acceptance for placing concrete.
   2. Unauthorized Excavation: When suitable bearing soil is not encountered at sub grade elevations shown and excavation is made to greater depth, the raft foundation, isolated and continuous footings shall be extended to the lower elevation with blinding concrete of the strength specified, or other suitable material approved by the Engineer at no additional cost to the Owner.
   3. In absence of shoring, deep excavation shall be carried out in a stepped manner to prevent vertical edges of deep excavation from collapsing or caving-in.

D. Excavation for Paved Areas and Kerbs
   1. Sub grades: Sub grade shall be approved by the Engineer before proceeding with construction of pavements and kerbs.
      a. The top 300 mm of sub grade resulting from excavation shall be free of unsuitable material and be equal to the following percentages of maximum density at optimum moisture content when tested in accordance with ASTMD1557:

         i) Under paved areas and kerbs: 95%

b. If the sub grade does not meet the above requirements after proof-rolling, compact the sub grade by rolling with suitable compaction equipment to obtain the density specified.

2. Unauthorized Excavation: Excavations performed below the elevations shown or specified shall be filled and compacted as hereinafter specified for filling and compacting, with no additional cost to the Employer.

E. Excavation for General Grading: Excavations made below the elevations shown or specified, unless authorized by Variation Order shall be filled and compacted as hereinafter specified for filling and compacting with no additional cost to the Employer. Payment for additional excavation, if authorized by the Engineer will be made in accordance with the requirements of the Contract Documents.

F. Trench Excavation: Trenches for piping and utilities unless otherwise specified shall be not less than 400 mm nor more than 600 mm wider than the outside diameter of the pipe to be laid therein. Bottoms of trenches shall be accurately graded with bell holes scooped out to provide uniform bearing and support of pipe and utilities on undisturbed soil throughout its entire length, except where other means of supporting pipe are indicated. Rock materials shall be excavated to 150 mm below pipe invert and bed backfilled with drainage fill, well tamped in place, with no additional cost to the Employer.

3.02 FILLING AND COMPACTING

A. Materials: Materials for fill and backfill shall be as hereinbefore specified, obtained from the required excavation on Site, if acceptable, or from borrow sources.

B. Utilization of Excavated Materials: Suitable excavated material for fill and backfill as defined in Paragraph “Materials”, shall be approved by the Engineer. Material which is suitable for use as fill under exterior slabs and pavings and for backfill shall be separated from material which is only suitable for general grading.

C. Borrow: Provide additional material, if required, at no additional cost to the Employer. Acceptable borrow shall consist of suitable material as hereinbefore specified. Representative samples of each type of borrow material considered suitable shall be delivered to the Engineer for approval.

D. Placing: Place fill materials in horizontal loose layers in such manner as to produce a uniform thickness of material. Placement shall start in the deepest area and progress approximately parallel to the finished grade. Thickness of layers after compacting shall not exceed 200 mm for cohesive soils nor 300 mm for cohesion less soils.

1. No fill material shall be placed on areas where free water is standing or on surfaces which have not been approved by the Engineer.

E. Compaction:
   1. Compact each layer of fill with equipment to achieve the following percentages of maximum density at optimum moisture content when tested in accordance with ASTM D1557:

LOCATION	% MAX. DENSITY
a. Under Isolated and Continuous Footings	95
b. Under Paved Areas and Kerbs	95
c. Under Mat slabs and Slabs on Grade	95
d. General Grading	90

   2. Do not compact soil when the moisture content varies more than 3% from the optimum moisture content. Maintain moisture content by wetting or drying manipulation. Suspend compacting operations when satisfactory results cannot be obtained because of rain or other unsatisfactory conditions.
   3. In lieu of drying by manipulation, hydrated lime, monohydrated lime or similar beneficial ingredients may be used to reduce the moisture content, reduce the plasticity index or improve workability. Apply such ingredients in a manner and quantity as recommended by the manufacturer or as required by the Government Testing Station and approved by the Engineer without any additional cost to the Employer.

F. Backfilling Against Foundation Walls: After completion of foundation walls and removal of forms, clean the excavation of all rubbish and debris before application of waterproofing and placement of backfill. Backfill as hereinbefore specified for fill operations. Maintain symmetrical backfill loading and compact each layer by hand tampers or other suitable equipment.
   1. Do not backfill against foundation or basement walls until completion of supporting floor construction to top of backfill or to first level above top of backfill unless approved by the Engineer. In placing backfill, take special care to prevent wedge action, eccentric loading or overloading of the structure by equipment used in compacting backfill material, and to prevent damage to waterproofing on walls.

3.03 FIELD QUALITY CONTROL

A. Testing of Materials: The independent Testing Agency shall perform all tests herein specified and any additional tests as may be required and submit test reports to the Engineer including the following:
   1. One optimum moisture - maximum density curve for each type of soil encountered in sub grades and fills under isolated and continuous footings, slabs on grade and paved areas. Determine maximum densities in accordance with ASTM D1557.
   2. Each type of borrow material shall receive:
      a. Mechanical Analysis. ASTM D422/AASHTO T88.

b. Plasticity Index Determination. ASTM D4318/AASHTO T91.
c. Moisture-Density Curve Determination. ASTM D1557.
d. CBR test as a measure for bearing capacity when required.

3. The independent Testing Agency shall determine the suitability of materials to be used for fills and to the approval of the Engineer.

B. Testing of Sub grade and Fill Layers: Sub grades and fill layers shall be approved by the independent Testing Agency and the Engineer before construction of any further work thereon. Tests of sub grades and fill layers shall be taken as follows:
1. The top 300 mm of sub grade resulting from excavation shall have the maximum density at optimum moisture as hereinbefore specified. In fill areas, each layer of fill shall meet the required density as hereinbefore specified. Make at least one (1) field density test of the sub grade for every two hundred square meters (200 m2) of isolated and continuous footings, paved area or slabs on grade, but in no case less than three (3) tests. In each compacted fill layer, make one (1) field density test for every overlaying two hundred square meters (200 m2) of isolated and continuous footings, paved area or slabs on grade, but in no case less than three (3) tests. Perform field density tests in accordance with ASTM D1556 or ASTM D2167.
2. At foundation wall backfill take at least three (3) field density tests (ASTM D1556 or ASTM D2167) at locations and elevations as directed by the Engineer.

C. Cooperate with the independent Testing Agency in every respect in the performance of the required tests.

D. If, based on reports of the independent Testing Agency and inspection, the sub grade or backfills are found to be below the specified density, the Engineer may require additional compaction and testing and all this shall be carried out at the expense of the Contractor.

3.04 STORAGE AND DISPOSAL OF EXCAVATED MATERIALS

A. The following material shall be disposed of legally off the site unless otherwise directed by the Engineer.
1. Unsuitable excavated materials.
2. Excess excavated material.

B. Storage on site of suitable excavated material for later reuse on site, in temporary spoil heaps, is subject to approval by the Engineer for location, quantity and quality of fill material stored. Approval can be rescinded at any time. No claim for additional compensation will beallowed if site storage is not approved.

C. Material resulting from clearing and grubbing operations must not be burnt on the site. Dispose of all such material legally off the Employer’s property and surrounding areas.

3.05 PROTECTION

A. Safety:
   1. Provide a temporary and strong barrier on the edges of the trench excavation as a safety measure.
   2. Keep stores and material away from the edge of the trench excavation so as to allow free movement of laborers and staff around the excavations.
   3. Use sturdy steel or timber stairs to climb up and down the excavated trenches. Do not use ladders.

B. Pumping and Drainage: Excavate areas so as to afford adequate drainage. Control grading to prevent water running into the excavated areas. Until the work is completed, remove water that may interfere with the proper performance of the work or cause ponding.

C. Perform all work in such manner as to ensure the safety of the Works, the public and adjoining sites and so as to cause as little inconvenience as possible to the public and adjoining owners, and allow in the Tender for all necessary precautions to that end.

Shoring

SECTION 024300
SHORING

Part 1 - GENERAL

1.01 SUMMARY

A. General:
   1. The shoring work shall be as required and includes, but is not limited to the following:
      a. Shoring necessary to protect existing buildings, streets, walkways and utilities and excavation against loss of ground or caving embankments.
      b. Maintenance of shoring.
      c. Cutting off top of shoring system.
   2. Type of shoring system includes, but is not limited to the following:
      a. Soldier 'H' piles.
      b. Ground anchors.
      c. Timber lagging.
      d. Concrete encasing to piles below the levels as shown on the Drawings.
      e. Any other requirement as directed by the Engineer.

1.02 SHORING SYSTEM DESIGN

A. The Contractor is required to provide a complete shoring system.

B. Under the terms of this Specification the responsibility for the design of the shoring shall rest entirely with the Contractor. Should the Contractor sub-let this section of the works to a specialist Sub-Contractor, the appointment of that specialist Sub-Contractor shall be subject to the approval of the Engineer, in addition to the review and acceptance at Tender Review Stage.

C. Upon approval by the Engineer of the Specialist Sub-Contractor, the design and preparation of all working drawings shall be undertaken by the Specialist Sub-Contractor. Such subletting shall not relieve the Contractor of any of his Contractual obligations or responsibilities towards the Employer.

1.03 SUBMITTALS

A. Submit design drawings for the shoring system together with construction techniques and all relevant structural design calculations to the Engineer for review and approval.
   1. Design shoring for final required excavation level. The bottoms of the 'H' piles shall be at required levels.

1.04 QUALITY ASSURANCE

A. Specialist Subcontractor for the works shall meet the requirements as specified in the Documents.

B. Contractor/Installer Qualifications: Shoring in accordance with the requirements of the Contract Documents shall be provided and executed by a specialist Sub Contractor approved by the Engineer. The Contractor shall ensure that at no time during the piling operations the surrounding area is disrupted by noise and vibrations.

C. Professional Engineer Qualification: Assign supervision of shoring work to a qualified engineer experienced in the field and approved by the Engineer.

D. Requirements of Regulatory Agencies: Comply with local codes and ordinances of governing authorities having jurisdiction.

1.05 PROJECT CONDITIONS

A. Before starting work, check and verify governing dimensions and elevations. In company with the Engineer, jointly survey condition of adjoining properties. Take photographs, as directed by the Engineer, recording any prior settlement or cracking of structures and pavements. Prepare a list of such damages, verified by dated photographs, and signed by the Contractor, the Engineer and others conducting the investigation.

B. Survey adjacent structures, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations. Locate datum level used to establish benchmark elevations sufficiently distant so as not to be affected by movement resulting from excavation operations.

C. Protect existing active sewer, water, gas, electricity, telephone and other utility services and structures.

Part 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide suitable shoring materials which will support loads imposed. Materials shall be as selected by the Contractor and approved by the Engineer. Such approval shall not absolve the Contractor from his responsibility to provide adequate shoring in accordance with the requirements of the Contract.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, ASTM A 992/A 992M.

C. Timber Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application and as shown on drawings.

D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

Part 3 - EXECUTION

3.01 SHORING

A. General: Protect the site from caving and unacceptable soil movement and install shoring to faces of excavation as indicated on the Drawings.

B. The contractor must make his own enquiries, and submit to the Engineer for approval, his own design for the shoring system he proposes to use together with all relevant calculations.

C. Shoring system shall be adequately anchored to resist earth and hydrostatic pressures.

D. Bore holes to their final levels, erect soldier or 'H' piles in the bored holes, align to true line and level, and encase bottom portion of the piles below as indicated in the drawing with concrete. Where shoring is to be later removed (i.e. where outside the property line) wrap the end of the 'H' piles in a suitable approved material to facilitate their withdrawal.

E. During excavation under this Contract, resurvey bench marks weekly. Maintain accurate log of surveyed elevations for comparison with original elevations. Promptly notify the Engineer if changes in elevations occur or if cracks, sags or other damage is evident. Propose remedial work and execute as approved by the Engineer.

F. The shoring within the boundaries of the property line may remain in place following the completion of the works included in this Contract but the Contractor will be required to cut off the top of the shoring (minimum two (2) metre below finished ground or paving level), and make openings for service and utility connections, as and when required by the Engineer.

Concrete Accessories

SECTION 031500
CONCRETE ACCESSORIES

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Concrete accessories complete in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   1. PVC or rubber water stops, conventional type.
   2. Fixing.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM C 572-81 — Method for Chemical Analysis of Chrome-Containing Refractories and Chrome Ore.
   2. ASTM D 638-82a — Test Method for Tensile Properties of Plastics.
   3. ASTM D 746-79 — Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   4. ASTM D 747-83 — Test Method for Stiffness of Plastics by means of a Cantilever Beam.

B. Corps of Engineers (CRD)
   1. CRD-C 513 — Rubber Water Stops.

1.03 SYSTEM DESCRIPTION

A. PVC Water Stops
   1. To be manufactured from PVC or other approved which shall not contain recycled or filler material.
   2. Minimum tensile strength 13.7 N/mm².
   3. Elongation at break: Minimum 285%.

B. Rubber Water Stops
   1. To be manufactured from Rubber to comply with US Federal Specification 22R-601a.
   2. Minimum tensile strength: 20.7 N/mm².
   3. Elongation at break: Minimum 45%.

1.04 SUBMITTALS

A. Product Data: Submit to the Engineer for review the manufacturer's specifications and installation instructions for water stops including certified laboratory test reports and other data as may be required to show compliance with the contract documents.

B. Shop Drawings: Submit to the Engineer in accordance with the requirements of the contract documents, shop drawings showing details (Scale 1:5) of location of items of work, joining details, fixing method etc.

C. Sample: Submit to the Engineer in accordance with the requirements of the contract documents, sample of Water Stops specified. Provide at least three (3) samples of proposed types, including prefabricated joints and junctions.

1.05 QUALITY ASSURANCE

A. Installer Qualification: Water Stops shall be installed in place by an approved installer having qualifications/experience which meet the requirements specified in Documents I and II.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the project site in manufacturer's unopened containers, clearly indicating manufacturer's name, type, size and other identifying information.

B. Store materials in a dry location, off the ground and in a manner to prevent damage, deterioration and intrusion of foreign matter. Replace materials which have been damaged or are otherwise unfit for use, as directed by Engineer.

1.07 WARRANTY

A. Manufacturers shall provide their standard warranties for products furnished under this section of the Specification.

Part 2 - PRODUCTS

2.01 MANUFACTURES

A. Water Stops

1. W.R. Meadows of N. CA.
   865 Teal Drive
   P.O. Box 907
   Benicia, CA 94510

2. Grace Construction Products Waterproofing Systems
   W.R. Grace Limited Ajax Avenue Slough
   Berkshire SL1 4BH United Kingdom

3. Specialty Engineering Chemicals
   P.O. Box 61347
   Dubai – United Arab Emirates

4. Polybit
   P.O. Box 48539
   Sharjah - United Arab Emirate

5. Chem Rex Inc. USA
   889 Valley Park Drive
   Shakopee, MN 55379
   U.S.A.

6. Or approved equal

B. The products and manufacturers specified herein are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable subject to the Engineer's approval. The decision of acceptability shall rest with the Engineer.

2.02 MATERIALS

A. Water Stops

1. Type: Extruded pre-formed molded PVC / Rubber
2. Joints: Heat sealed or as recommended by manufacturers
3. Size: 240 mm wide unless noted otherwise

Part 3 - EXECUTION

3.01 EXAMINATION

A. Examine the substrates and adjoining construction on the conditions under which work is to be installed. Do not proceed with work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.

3.02 INSTALLATION

A. Fix water stops in basement, water tanks, construction joints (external type), and to locations indicated on drawings.

B. Install to give a continuous diaphragm in each joint.

C. Pre-molded water stop shall be in maximum possible length to minimize the number of end joints.

D. Make joints at ends and intersections in the manner most appropriate to the material used and according to manufacturer recommendations.

E. Joints shall:
   1. Fully develop effective water tightness, equal to that of the continuous water stops material;
   2. Permanently develop not less than 50% of the mechanical strength of the parent section;
   3. Permanently retain their flexibility.

F. Do not fix with nails or ties through the web of water stop.

G. Replace damaged water stops before concreting.

H. Fabricate field joints in water stops in accordance with manufacturer's printed instructions.

3.03 PROTECTION

A. Support and protect exposed water stops during progress of work.

Cast- in- Place Concrete

SECTION 033000
CAST-IN-PLACE CONCRETE

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: All cast-in-place concrete work shown on the drawings or inferable There from and/or as specified in accordance with the requirements of the Contract Documents. Work includes but is not limited to following:
   1. Foundation
   2. Column necks
   3. Formworks.
   4. Materials.
   5. All general concrete works and related finishes.
   6. Testing.

B. Related Sections:
   1. Section 033500 - Concrete Finishes
   2. Section 035300 - Concrete Toppings

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM A 184/A 184M-06: Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
   2. ASTM A 615/A 615M-08: Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   3. ASTM C 31/C 31M-06: Practice for Making and Curing Concrete Test Specimens in the Field
   4. ASTM C 33-07: Specification for Concrete Aggregates
   5. ASTM C 39/C 39M-05: Test Method for Compressive Strength of Cylindrical Concrete Specimens
   6. ASTM C 42/C 42M-04: Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   7. ASTM C 94/C 94M-07: Specification for Ready-Mixed Concrete
   8. ASTM C 109/C 109M-07: Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
   9. ASTM C 143/C 143M-08: Test Method for Slump of Hydraulic-Cement Concrete
   10. ASTM C 150-07: Specification for Portland Cement
   11. ASTM C 172-07a: Practice for Sampling Freshly Mixed Concrete

12. ASTM C 173/C 173M-08: Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
13. ASTM C 231-08: Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
14. ASTM C 494/C 494M-08: Specification for Chemical Admixtures for Concrete
15. ASTM C 1064/C 1064M-05: Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
16. ASTM C 1077-07a: Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

B. British Standards Institute (BSI)

1. BS 12 "Portland Cement".
2. BS 410 "Test Sieves".
3. BS 882 "Aggregates from Natural Sources".
4. BS 1305 "Batch Type Concrete Mixers".
5. BS 1881 "Methods of Testing Concrete".
6. BS 3148 "Tests for Water for Making Concrete".
7. BS 3797 "Lightweight Aggregates for Concrete".
8. BS 4027 "Sulphate-Resisting Portland Cement".
9. BS 4449 "Carbon Steel Bars for the Reinforcement of Concrete".
10. BS 4550 "Methods of Testing Cement".
11. BS 5075 "Concrete Admixtures".
12. BS 5328 "Concrete".

C. American Concrete Institute (ACI)

1. ACI 117-2006: Specifications for Tolerances for Concrete Construction and Materials
2. ACI 301-2005: Specifications for Structural Concrete
3. ACI 318-2008: Building Code Requirements for Structural Concrete
4. ACI 318M-2005: Building Code Requirements for Structural Concrete [Metric]
5. ACI CP-1-2008: Technical Workbook for ACI Certification of Concrete Field Testing Technician - Grade I

D. The applicable provisions of the following standard publications, codes and specifications shall apply throughout the cast-in-place concrete works:
   1. CRSI "Placing Reinforcing Bars".
   2. K.S.S.100 "Testing Techniques for Portland Cement Properties".
   3. CIRA Data Sheet "Concrete Pressure on Formwork" (Concrete Society Technical Report No.13).

1.03 SYSTEM DESCRIPTION

A. Performance:
   1. This Specification Section shall govern all cast-in-place concrete work for the complete project except where more stringent or specialized requirements are indicated. All work shall be performed to secure for the entire project homogeneous concrete having the required strength, surface finish, materials, durability, and weathering resistance, without planes of weakness or other structural defects, and free of honeycombs, air pockets, voids, projections, offsets of plane and other defacements of concrete. The Contractor will be fully responsible for any defects or damage in the building arising from faulty materials or workmanship and the costs of remedial measures in order to ensure that the completed work complies with the Contract Documents.

B. Design Requirements:
   1. Base construction methodology on the construction indicated in the Contract Documents. No alterations or substitutions of the structural systems shown on the Drawings will be permitted unless otherwise specified.
   2. Supervise and coordinate all phases of the concrete construction process and be responsible for the complete manufacturing process for all concrete work. All methods of manufacture and practices of handling raw materials and manufactured concrete shall be reviewed by the Engineer prior to execution of the concrete work.
   3. Only materials of known quality shall be incorporated in the work. All materials shall be properly selected, reviewed with the Engineer before use, and maintained during shipment, storage and use. Construction systems and techniques shall be properly selected, reviewed with the Engineer before use, and maintained throughout the complete concrete construction phase. Adequate spare equipment, parts, additional components and repair facilities shall be available for all tools and equipment.
   4. Regardless of reviews and approvals by the Engineer be responsible for all materials, methods and the work, and if any work does not satisfy the Contract Documents, implement removal, replacement or remedial work and revise procedures or materials to prevent recurrence of unacceptable work at no additional cost to the Employer.

1.04 SUBMITTALS

A. Shop Drawings: Submit detail fabrication and placement drawings for all formwork and reinforcing steel which are correlated with forming and concrete placement techniques and requirements.
   1. Reinforcing shall be detailed based on construction joint locations if existing which shall have been shown on shop drawings reviewed and approved by the Engineer.
   2. The drawings shall be in such detail as to assure that difficulties in execution of the work in the field are minimized.
   3. The drawings shall consist of sections, plans and details clearly showing locations, sizes and spacing of all reinforcing steel, supporting bars and accessories. Include on the shop drawings, schedules and diagrams to indicate bends, sizes and lengths of all reinforcing steel bars.
   4. A separate set of shop drawings, which shows the construction joint locations, shall show all floor openings, wall openings and edges of concrete. Floor, wall openings and sleeves for all mechanical, plumbing and electrical work shall be coordinated with the respective trades and shown on these shop drawings in accordance with the criteria indicated on the Contract Drawings and contained in the various applicable Sections of the Specification.
   5. No work shall be fabricated until all shop drawings have been reviewed and approved by the Engineer (with corrections and re-submittals as required by the Contract Documents). After review and approval by the Engineer, furnish all copies needed for fabrication and erection, and for use of other trades.
   6. Be fully responsible for furnishing and installing all materials called for or required by the Contract Documents even though these materials may have been omitted from the reviewed shop drawings.
   7. Submit shop drawings for all formwork showing locations of joints, tie bolts, cones, dummy cones, openings, chamfers, inserts, fittings and accessories for the approval of the Engineer before fabrication of formwork.
   8. Submit design calculations in accordance with ACI Standard 301, Chapter 4, Para. 4.2, wherever required for the supporting system of the formwork along with the shop drawings for the supporting system, for approval of the Engineer.

B. Samples
   1. Provide cut lengths of reinforcing as requested by the Engineer for testing or evaluation by an approved Testing Agency, selected in accordance with the requirements of Contract Documents. The independent Test Agency shall be responsible for conducting and interpreting the tests, shall state in each report whether or not the test specimens comply with all requirements of the Contract Documents and shall specifically note any deviation there from. The Contractor shall not fabricate any reinforcing bars prior to the approval of the Engineer.

2. Provide samples of all materials and concrete accessories of every type proposed for use including component parts of prefabricated formwork systems and manufacturer's technical literature relating thereto. Prepare mock-ups and carry out such tests on the proposed prefabricated formwork systems as may be required by the Engineer in order that he may be satisfied as to the system's suitability.
3. Furnish reinforcement and accessories for sample panels and mocked-up portions of the structure as required using all materials and techniques as they will be used in actual construction.

C. Mill Tests: Furnish the Engineer with certified mill test reports for cement, steel reinforcement.

D. Certifications for Admixtures: As specified under admixtures.

E. Test Reports: Submit preliminary test results for the Engineer's approval at least three weeks prior to the beginning of the work. In addition to the test reports specified under "Quality Control", submit the following directly to the Engineer:
   1. Preliminary Design Mix Reports (BS 8110 Section 6).
   2. Aggregate Soundness Test Reports (ASTM C88).
   3. Aggregate Staining Test Reports (ASTM C641).
   4. Air Entrainment Test Reports (ASTM C260).

1.05 QUALITY ASSURANCE

A. In compliance with Document I and II submit proposed name of independent Testing Agency for the approval of the Engineer. Employ at no extra cost to the owner the approved Testing Agency to perform all tests and submit reports specified in this section. Approval may be withdrawn at the discretion of the Engineer and an alternative Testing Agency approved.

B. Preliminary Tests (Trial Tests)
   1. Target Mean Strength: The concrete mix shall have at least the required minimum cement content and mean strength greater than the required characteristic strength by at least the current margin. The current margin shall be taken as the lesser of:
      a. 1.64 times the standard deviation of cube tests on at least 100 separate batches of concrete of nominally similar proportions of similar materials and produced over a period not exceeding 12 months by the same plant under similar supervision, but not less than one sixth (1/6) of the characteristic strength for concrete of grade 140 or not less than 37.50 kg/cm2 for concrete of grade 200 or above.
      b. 1.64 times the standard deviation of cube tests on at least 40 separate batches of concrete of nominally similar proportions of similar materials and produced over a period exceeding 5 days but not exceeding 6 months by the same plant under similar supervision, but not less than one third (1/3) of the characteristic

strength for concrete of grade 140 or not less than 75 kg/cm2 for concrete of grade 200 or above. If enough data is not available to satisfy the requirements of either (a) or (b) abovementioned, the margin shall be taken as two-thirds (2/3) of the characteristic strength for concrete of grade 140 or 100 kg/cm2 for concrete of grade 200 or above. When required characteristic strength approaches maximum possible strength of concrete a smaller margin but not less than 75 kg/cm2 shall be permitted. Evidence shall be submitted to the Engineer for each grade of concrete showing that at the intended workability, the proposed mixed proportions and manufacturing method will produce concrete of required quality. Declare any change in source of material and any change in cement content, nature and source of each material, full details of tests on trial mixes, proposed quantities of each ingredient per cubic metre of fully compacted concrete.

2. To establish the suitability of any material used in the concrete work, unless specified otherwise, make preliminary tests and prepare design mixes, in accordance with ACI-301, Chapter 3, Paragraph 3.8, Method 1 or Method 2, in a design laboratory acceptable to the Engineer.

3. In addition to the tests required to establish the suitability of materials, make one test for each design mix to verify that the total Chloride (Cl) ion content and the total Sulphate (SO3) content of each mix is within the specified limits. Perform Chloride tests in accordance with “Standard Method of Sampling and Testing for Total Chloride Ion in Concrete” as contained in Report No. FHWA-RD-77-85 published by U.S. Department of Transportation, Federal Highway Administration. Perform Sulfate (SO3) tests in accordance with ASTM C114.

4. Trial Mixes
    a. Where trial mixes are requested by the Engineer, three separate batches of concrete shall be made using materials likely to be typical of the proposed supply and preferably under full scale production conditions.
    b. Sampling and testing shall be strictly in accordance with B.S.1881. The workability of each batch of concrete shall be determined and three (3) cubes made from each batch of concrete for test at 28 days. A further three (3) cubes from each batch shall be made for test at earlier age. The trial mix proportions shall be approved by the Engineer if the average strength of nine (9) cubes tested at 28 days exceeds the specified characteristic strength by the appropriate margin or if nine (9) cubes tested at an earlier age indicate that it is likely to be exceeded by this amount. The appropriate margin is the margin as given in Clause 1.05.B.1 herein for concrete of nominally similar proportions and of similar materials to the trial mix. For this purpose if the trial mix does not differ by more than 30 kg/m3 of cement from a reference mix of similar workability, then the proportions may be regarded as “nominally similar” and the current margin for the reference mix can be taken as the appropriate margin for the trial mix. If trial mixes are required to demonstrate that the maximum free water/cement ratio is not exceeded, two batches shall be made in a laboratory with cement and saturated sand surface dry aggregate known from past records of the suppliers of the materials to be typical. The proposed

mix proportions shall be accepted only if both batches have the correct cement content and free water/cement ratio below the maximum specified value at the proposed degree of workability.

5. Have a representative present when the preliminary tests are made. Whenever a change of brand or source for any of the concrete ingredients occurs, additional "preliminary tests" will be required and the cost of these additional tests shall also be borne by the Contractor.

C. Plant and Field Tests and Inspection

1. Concrete work will be subject to detailed inspection and tests at the plant and in the field. Notify the Engineer one day in advance of concrete work. Inspection, field tests and sampling of concrete taken from the job will be carried out under the direction of the Engineer. Likewise the conducting of tests carried out by the Contractor shall be under the direction of the Engineer.

2. Concrete shall be produced in accordance with BS 5328. BS 5328 requires that tests are made on the constituent materials in accordance with the relevant British Standard, (refer to Part 2 of this Section), and that control tests are made on concrete to ensure compliance with the specified requirements.

3. When tested, the concrete shall meet the appropriate requirements specified in BS 5328, ie.:
   a. Characteristic compressive strength;
   b. Specified mix proportions;
   c. Minimum or maximum cement content;
   d. Maximum free-water/cement ratio;
   e. Workability;
   f. Air content of concrete;
   g. Temperature of fresh concrete;
   h. Density of fully compacted concrete.

4. Rate of sampling and testing shall be as specified and/or as directed by the Engineer. The cost of sampling and testing shall be borne by the Contractor.

5. Facilitate sampling procedure and provide labour and material as required. Notify the Engineer when reinforcing steel is in place in order to facilitate any inspection he deems necessary. Submit checking sheets before placing concrete. Do not place concrete until these inspections have been completed and all deficiencies reported by the Engineer have been corrected to the Engineer's satisfaction.

6. Supply all moulds required for tests as described below, using moulds of the same type and manufacture for making all test specimens. If field tests show

excessive slumps or other violations of the Contract Documents, the entire batch of concrete from which the sample in question was taken will be rejected and shall be removed from the site at the Contractor's expense. The Engineer will inspect all concrete operations in the plant and in the field.

7. If ready-mix concrete is used, each load of concrete arriving at the job shall be accompanied by a delivery ticket which shall be subject to checking by the Engineer at the plant and which shall contain the following information:
    a. The strength of the mix of concrete being delivered.
    b. The exact time the cement and aggregate were discharged into the delivery truck. If upon reaching the job the concrete cannot be placed within the time limits stated, or if the type of concrete delivered is incorrect, the Engineer will reject the load and it shall be removed from the site at the Contractor's expense.
    c. List of admixtures and concentration percentage.

8. Under the supervision and direction of the Engineer the Contractor will take specimens of each class of concrete from different locations on the job as follows:
    a. At least twelve (12) specimens for each 40 cubic metres or fraction thereof of each class of concrete and in any case not less than twelve (12) specimens for any one day's operations.
    b. Test specimens will be taken at pouring locations to give a fair average of the concrete in the part of the construction indicated.
    c. Samples will be obtained in accordance with B.S.1881.
    d. At least two slump tests: ASTM C143.
    e. Testing shall conform to B.S. 1881 in making, curing and subsequently handling test specimens, except as modified herein. Cubes shall be engraved with the date of placing and the serial number of the cubes (1 to 12) plus a universal serial number representing the number of the pour.

    f. The cubes shall be placed in laboratory storage on Site under moist curing conditions at approximately 21`C within 24 hours after moulding and maintained therein until ready for testing at the Site Laboratory. Three cube specimens will be tested at seven days, and if the seven day strength is deficient, the Contractor will be notified. Three cubes will then be tested at 14 days, three cubes at 28 days, and the remaining 3 cubes will be tested as directed by the Engineer having been cured with curing compound for 28 days.
    g. Two unit weight and yield tests: ASTM C138.

9. Under the supervision and direction of the Engineer the Contractor will take specimens of each class of concrete, and an independent Testing Agency, approved by the Engineer will perform one test for each 100 cubic metres to verify that the total Chloride ion content and the total Sulphate content are each within the specified limits. As soon as the concrete is no longer plastic, but in no event more than 24 hours after placement, the Testing Agency will perform tests in accordance with the procedures herein specified under Paragraph 1.05.B.3.

10. Keep records of all specimens taken and tests made using a proforma approved by the Engineer. Such records shall be signed by the Contractor and the Engineer.

D. Change of Current Margin: When the results of a sufficiently large number of tests show that the previously established margin has significantly varied, a change in the current margin used for judging compliance with the specified characteristic strength may be appropriate. Recalculation of the margin shall be carried out as before, but the adoption of recalculated value will not generally be justified if the two values differ by less than 18% when based on tests on 40 separate batches or less than 11% when based on tests on 100 separate batches, or less than 5% when based on tests on 500 separate batches. This recalculated margin if adopted becomes the current margin for the judgment of compliance with the specified characteristic strength of concrete.

E. Testing Plan:

1. Each 3 cubes shall be made from a single sample taken from a randomly selected batch of concrete. The sample shall be taken from the point of discharge from the delivery vehicle. The characteristic strength of concrete shall comply with the following requirements:
    a. The average strength determined from any group of four consecutive sets of test cubes exceeds the specified characteristic strength by not less than 0.3 times the current margin.
    b. Each individual test result is greater than 85% of the specified strength. The current margin shall be taken as given in Paragraph 1.04.A. If only one cube result fails to meet the second requirement mentioned above, that result may be considered to represent only the particular batch of concrete from which that cube was taken, provided the average strength of the group satisfied the first requirement. If more than one cube fails to meet the second requirement or if the average strength of any group of four consecutive test cubes fail to meet the second requirement, then all the concrete in all the batches represented by all such cubes shall be deemed not to comply with the strength requirements.

2. Enforcement: When the average strength of four consecutive test cubes fail to meet the first requirement mentioned in the testing plan, the mix proportions of subsequent batches of concrete shall be modified to increase the strength. The Engineer shall decide as to what action may be taken for test cubes that fail to meet the requirements mentioned. In estimating the quality of the sub-standard concrete and in determining the action to be taken the following shall be considered:
    a. The validity of test results and confirmation that specimen sampling and testing have been carried out in accordance with B.S. 1881. Concrete shall be judged by the strength of specified characteristic strength, together with the cement content, in comparison with the specified minimum cement content.
    b. The mix proportions actually used in concrete under investigation.

c. The actual section of the structure represented by the test cubes.
d. The possible influence of any reduction in concrete quality in the strength and durability of this section of structure. The Engineer may require tests to be carried out on the hardened concrete in the structure, apart from other tests mentioned in the Contract Documents. The cost of all such tests and making good will be borne by the Contractor irrespective of the test results. Where tests show that concrete is below specified strength, remove all, or a part of, the concrete in all of the batches deemed not to comply with the strength requirement as directed by the Engineer. Full cost of removal of low strength concrete and its replacement with concrete of proper specified strength shall be borne by the Contractor, without any additional cost to the Employer.

3. Strength: Compliance with the specified characteristic strength shall be judged by tests made on cubes at an age of 28 days. Not more than 5% of the cube test results shall be allowed to fall below the characteristic strength of concrete.

Part 2 - PRODUCTS

2.01 MATERIALS

A. The products and manufacturers specified herein are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable subject to the Engineer's approval. The decision of acceptability shall rest with the Engineer.

B. Cement
   1. Alkali Content For All Types of Cement: Maximum 0.6% equivalent of Sodium Oxide (Na2O) (ASTM C227).
   2. Ordinary Cement: B.S.12 or ASTM C150, Type I or K.S.S.36, non-staining.
   3. Sulphate Resisting Portland Cement: B.S.4027 or ASTM C150, Type V.
   4. Sulphate resisting cement shall be used as directed by the Engineer in all work below the ground floor level which is in contact with soil or waterproofing or protection board or vapour barrier.
   5. Cement shall originate from sources and manufacturers acceptable to the Engineer and shall be delivered in sealed bags. Only one brand of cement shall be used for each type of cement. When received at the batch plant, all bags shall be intact and cement shall be completely dry. Cement exposed to moisture or wetting of any kind during shipment or storage shall not be used on the job.
   6. Stale cement or cement with cakes or lumps shall not be used.
   7. All cement stored at site shall be kept thoroughly dry and shall be stored in water tight sheds on a floor raised at least 200mm above ground. Cement stacks shall have labels indicating dates of manufacture and arrival at the storage site. A maximum of fifteen bags shall be stacked if the storage period is not more than four weeks and eight bags if the storage period is over four weeks but not more than three months. Any cement stored for more than three months shall not be used without the explicit written permission of the Engineer.
   8. When tests performed on field samples, subsequent to the original approval tests, show that the cement does not comply with the Specifications, the entire consignment from which the sample was taken shall be rejected. Rejected cement shall not be permitted in storage areas or on the Site and shall be removed within twenty four hours.
   9. Cement shall be protected from direct exposure to sun. Cement temperature shall not exceed 50° C.
   10. All Type V Cement shall have tricalcium aluminate content not exceeding five percent (5%).

C. Aggregate

1. In general, aggregate shall comply with B.S. 882, “Concrete Aggregates from Natural Sources”, or ASTM C33, and shall be graded in accordance with these requirements, irrespective of whether concrete is mixed on site or elsewhere. The contractor shall nominate the source of supply and shall provide grading curves of aggregate for approval.
2. Aggregate shall consist of fine sand or stone aggregates and crushed stone, crushed rock or gravel. Separate stockpiles of fine aggregate and each size of coarse aggregate gradation shall be used. Each aggregate type shall be from a single consistent source.
3. Storage piles of aggregates shall be placed on concrete hardstand which has good drainage. Stockpiles shall have walls separating adjacent materials and shall be covered to preclude segregation or intrusion of foreign materials and to preserve the gradation. Sufficient storage shall be maintained to assure placement of concrete at the necessary rate. Use properly constructed sheds to protect aggregates from direct sun radiation and from blowing sands.
4. Aggregates shall be hard, durable, clean and free from adherent coatings and dust and when directed by the Engineer, shall be washed and sieved to remove deleterious substances.
5. Aggregates shall not contain harmful materials, such as salts, iron pyrites, coal, mica, shale or similar particles which may reduce the strength or durability of the concrete. Aggregates shall not contain any material that may be chemically active with reinforcement or that may react to cause efflorescence or that may be alkali reactive.
6. Reactive limestone aggregates such as “Dolomitic” shall not be used.
7. The grading of each size of aggregate from each pit, quarry or other sources of supply shall be determined at least once weekly. The results of such tests shall be reported to the Engineer and shall be used to check whether the gradings are similar to those of the samples used in the establishment of batch weight used.
8. Supplier’s certificate shall be submitted to the Engineer for approval of the source of aggregate.
9. Aggregate for exposed unpainted concrete shall be specially selected for colour as approved by the Engineer and shall come from a single source.
10. All aggregates shall be screened and washed and shall have less than the following maximum salt contents as acid soluble chlorides and sulphates. The table also shows the maximum salt content allowed in the mixed concrete. Aggregates for coloured concrete must be approved by the Engineer prior to use.

	Chlorides	Sulphate
Percent of weight of fine aggregate	0.06	0.4
Percent of weight of course aggregate	0.03	0.4
Total percent in concrete as percent by weight of cement	0.1(OPC) 0.2 (SRPC)	4.0

11. Fine aggregates shall consist of natural sand or crushed gravel sand and shall comply with ASTM C33 or BS 882 "Concrete Aggregates from Natural Sources" having hard and durable particles or other inert materials having similar characteristics conforming to the following requirements:
    a. Fineness Modulus: 2.4 to 3.0 ASTM C125.
    b. Fineness modulus shall not vary more than 0.20 from value used in establishing mix proportions. If greater deviation, the use of such aggregates shall be discontinued until suitable adjustments in mix proportions can be made and reviewed.
    c. Magnesium Sulphate Soundness: Max. 5% loss, ASTM C88, 5 cycles.
    d. Potential Reactivity: Not reactive ASTM C289.
    e. Content of Clay Lumps: Max. 1% by weight ASTM C142.
    f. Gradation requirements as follows:

Size of Sieve Opening (Square Openings)	Percentage by Weight Passing - ASTM C33, C117
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 8 (2.36 mm)	80-100
No. 16 (1.18 mm)	50-85
No. 30 (0.60 mm)	25-60
No. 50 (0.30 mm)	15-30
No. 100 (0.15 mm)	3-10
No. 200 (0.075 mm)	0-5

    Other gradations not meeting the above requirements may be permitted upon submission of relevant data and review by the Engineer.
    g. Fine aggregates shall be free of organic materials (ASTM C40) and other foreign matter.
12. Coarse aggregates for concrete shall consist of crushed gravel or crushed stone. The crushing shall be regulated so that the material retained on the No. 8 (2.36 mm) sieve, at least 90 percent by weight shall consist of pieces

with at least one fractured face and at least 75 percent by weight shall consist of material with at least two fractured faces. In addition, the coarse aggregates shall meet the following requirements:

a. Magnesium Sulphate Soundness: Max. 5% loss. ASTM C88, 5 cycles.
b. Potential Reactivity: Not Reactive ASTM C289.
c. Abrasion: Max. 10% loss ASTM C131, 100 revolutions.
d. Flat and Elongated Particles: 3:1 max. 30% ASTM C125 5:1 max. 10%.
e. Content of Clay Lumps: Max. 0.5% by weight ASTM C142.
f. Shale: Max. 2% by weight.
g. Bulk Saturated Surface Dry Specific Gravity: Min. 2.58 ASTM C125.
h. Gradation requirements as follows:

Size of Sieve Opening (Square Opening)	Percentage by Weight Passing ASTM C33		
	1½ inch (37.5mm)	1 inch (25.4mm)	¾ inch (19.0mm)
	Size	Size	Size
2 inch (50.0 mm)	100	-	
1-1/2 inch (37.5 mm)	95-100	100	
1 inch (25.4 mm)	60-85	95-100	100
¾ inch (19.0 mm)	35-70	60-85	95-100
½ inch (12.7 mm)	20-50	25-60	60-75
3/8 inch (9.5 mm)	10-30	15-45	20-55
No. 4 (4.75 mm)	0-5	0-10	0-10
No. 8 (2.36 mm)	-	0-5	0-6

Other gradations not meeting the above requirements may be permitted upon submission of relevant data and review by the Engineer.

i. The maximum size of aggregates shall be 1 inch (25.4 mm) for columns, walls and basement slabs, and ¾ inch (19.0 mm) for slabs and beams. In addition, the maximum aggregate size shall not exceed 20 percent of the narrowest member that is being concreted, nor shall it exceed 75 percent of the clear spacing between adjacent steel reinforcement or between reinforcement and adjacent formwork.

13. Lightweight Aggregates for insulating concrete shall comply with ASTM C332.

D. Water

1. Water for washing aggregates and for mixing of concrete shall be clean, fresh and free of harmful matter such as oil, salts, acids, alkali, sewage, deleterious minerals or organic matter. Water shall be filtered to remove any colour or residues present due to contamination from water piping or transportation or storage methods.
2. Water shall comply with the requirements of BS 5328.
3. Water shall be tested in accordance with BS 3148.

E. Admixtures

1. Suitable admixtures of the following approved types may be incorporated in the concrete only with the prior written approval of the Engineer:
    a. Water reducing set retarders.
    b. Water reducing agents.
    c. Air entraining admixtures for lightweight concrete.
2. The Engineer shall be advised in advance of the following data:
    a. The typical dosage and detrimental effects of under-dosage and over-dosage.
    b. Chemical name(s) of the main active ingredient(s) in the admixture.
    c. Whether or not the admixture leads to the entrainment of air when used at manufacturer's recommended dosage.
    d. Admixtures containing chlorides in excess of 0.03% by mass of the cement, nitrates, calcium chloride, sulphides and sulphates shall not be used.
    e. Admixtures submitted for Engineer's approval shall be certified in writing by the manufacturer to be in compliance with B.S. 5075 OR ASTM C494.
    f. Air-entraining admixtures for lightweight concrete shall comply with ASTM C260 or B.S. 5075 : PART (2).
    g. The type of admixture selected in accordance with the above mentioned standards must be to the approval of the Engineer. All admixtures must be mutually compatible.
    h. Admixture used in the work shall be obtained from reliable manufacturers whose products have previously been used successfully in Islamabad or on other international projects in countries having similar climate to Islamabad.
    i. Admixtures shall be used in strict accordance with manufacturer's printed instructions and recommendations and shall be certified by the manufacturer to be suitable for use during hot weather extremes. Admixtures shall be stored safe from adverse temperatures in accordance with manufacturer's printed instructions or recommendations.
    j. The suitability and effectiveness of any admixture approved by the Engineer, shall be verified by trial mixes with the cements, aggregates and other materials to be used in the works before final approval is given.
    k. Notwithstanding what has been stated above, the Contractor must allow in his Tender for testing the type of admixture he proposes to use.
    l. Admixtures where approved may be added only by using the manufacturer's recommended dispensers - no adding of admixture by hand is allowed.
    m. The entire amount of materials used for concrete shall have controlled sources of individual components such that the total mix meets the requirements of the Contract Documents. Unless specified otherwise, the total Chloride (Cl) ion content in the entire mix shall not exceed 0.20 percent of the weight of cement when SRPC is used and 0.1 percent when OPC is used. The total water-soluble Sulfate (S03) content in the entire mix shall not exceed 4 percent SO3 of the weight of cement in the mix. The total Calcium Chloride (Ca Cl2) content in the total mix shall not exceed 0.01 percent of the weight of cement.
    n. The total alkali content of the concrete mix of Na2O equivalent shall not exceed 3 Kg/m3. All sources of alkali shall be taken into account for calculating the total alkali content. In particular the contribution of Sodium Chloride whether from aggregate or from mixing water must be included.

F. Reinforcement

1. Bar reinforcement shall be deformed bars complying with BS 4449 type 2 deformation having a characteristic strength (fy) not less than 4200 kg/cm2 (420 N/mm2) or complying with ASTM A615 grade 60 steel. Dowels projecting from typical flow beams to be rebent into concrete topping shall be Grade 40 (ASTM) Grade 50 (BS) hot rolled mild steel having a characteristic strength (fy) not less than 2500 kg/cm2.
2. Mesh reinforcement and wrapping fabric shall conform to BS 4483 OR to ASTM A185.
3. Reinforcement shall be cut and/or bent in accordance with BS 4466.
4. Bends in reinforcement shall have a substantially constant curvature. Where the temperature of the steel is below 5`C, special precautions may be necessary such as reducing the speed of bending or, with the Engineer's approval, increasing the radius of bending.
5. Where it is necessary to bend reinforcement projecting from concrete, care should be taken to ensure that the radius of bend is not less than that specified in BS 4466.
6. Where it is necessary to reshape mild steel bars previously bent, this should only be done with the Engineer's approval and each bar should be inspected for signs of fracture.
7. No welding of reinforcement shall be carried out without the Engineer's approval. Welding shall be in compliance with ACI 318 or BS 8110.
8. Bundle and tag reinforcement with suitable identification to facilitate sorting, transporting, storing and placing at the Site.
9. All reinforcement bars shall be cut and bent to shape as per the approved bar bending schedule. All bars shall be tagged showing the corresponding bar number as shown on the relevant Bar Bending Schedule.

G. Bar Supports

1. Spacer blocks with cast in tie wire may be used with written agreement of the Engineer for support of the bottom layer of reinforcing in the raft foundation slab only. The blocks shall be of minimum size and made from cement sand small aggregate mix to match surrounding concrete strength, appearance and durability.
2. Other support devices and spacers shall be of such materials and of adequate strength and approved design as to be durable and so as to prevent displacement and corrosion of reinforcing steel and prevent discoloration and spalling of concrete cover. The type of spacers acceptable shall be one of the following:
    a. High density plastic.
    b. Hot-dipped galvanized bar supports with plastic feet.
    c. Stainless steel.
3. Individual and continuous slab bolsters and chairs shall be of a type to suit the various conditions encountered and must be capable of supporting a 140 Kg (1.37 KN) concentrated load without measurable permanent deformation of the reinforcement or indentation of the supporting surface.

H. Testing of Reinforcement Steel
   1. Tests will be required by the Engineer on steel reinforcement and they shall be carried out in strict accordance with the provisions of the above British Standards. (BS 4449, 4757 and 4483).
   2. Tensile tests providing information on elastic limit, ultimate strength, and stress-strain curve will be required from each delivery of reinforcement and measurements will also be required of cross-sectional area and deformation/bond characteristics of deformed bars.
   3. The Contractor is to allow for four tensile and four bond tests, at his own cost, for each size of bar to be used in the concrete construction.
   4. One set of test results for each bar size shall be submitted to the Engineer three (3) weeks before concrete work commences on Site. Remaining tests will be carried out at the discretion of the Engineer.

   5. Further tests may be called for when the source of supply of reinforcement changes in which case the cost of such extra testing will be borne by the Contractor. When any test results do not conform to the above standard the reinforcement steel shall be removed from the Site and the cost of subsequent testing and any remedial work shall be borne by the Contractor.

I. Vapor Barrier: Polyethylene sheeting minimum 0.15 mm thick of approved manufacturer in accordance with ASTM E96 and E154.

J. Curing Materials:
   1. Liquid Membrane Compound: AASHTO M148 OR ASTM C309, Type 1-D with fugitive dye and Type 2; formulated to disintegrate after 28 days, and guaranteed not to affect the bond of applied finishes.
   2. Polyethylene Film: ASTM C171, 0.25MM thick, opaque black.
   3. Reinforced Waterproof Building Paper: ASTM C171, opaque.
   4. Burlap: AASHTO M182.
   5. Water: B.S. 5328 and B.S.3148.
   6. Methods for determining the efficiency of curing compounds shall be in accordance with ASTM C156.
   7. Notwithstanding what has been stated above, the Contractor must allow in his Tender for testing the type of curing compound he proposes to use.

K. Formwork:
   1. For unexposed surfaces and rough work, use Exterior Type Douglas Fire plywood, complying with BS 1204 Part 1(4) type BR, minimum 19 mm thick. Before reusing forms, withdraw nails and thoroughly clean surfaces to be in contact with concrete.
   2. For exposed surfaces not otherwise specified use special exterior Type Douglas Fir, complying with BS 1204 Part 1 (4) type to BP, minimum 19 mm thick OR high density (60-60) overlay plyform, Class 1 EXT-APA, sanded grade trade marked by the Engineered Wood Association having a hard semi-opaque resin-fibre overlay on both sides, minimum 19mm thick and

constructed so that finished concrete will be straight, smooth, dense, free from honeycombs, bulges, or depressions. Keep joints between plywood sections to a minimum and make tight and strongly backed so that adjoining edges remain flush and true. Unsightly joint marks will not be permitted. Cover joints on exposed surfaces with smooth-faced fibre reinforced tape as approved by the Engineer.

3. Location of joints must be submitted to the Engineer for approval.
4. Prefabricated formwork systems may be used for all classes of concrete provided the manufacturer's printed instructions and recommendations are followed and the system has been approved by the Engineer. Joints between sections of prefabricated forms shall be taped unless otherwise recommended by the manufacturer and provided always, in the case of such recommendation, the forms are water and mortar-tight to the Engineer's satisfaction.

L. Form Coating: Form wax of a type which does not import any stain to concrete nor interfere with the adhesion of any finish, sealant, waterproofing material applied to any concrete surface and must be approved by the Engineer.

M. Form Ties: For securing forms where surfaces will be exposed in the finished work, use tie screws with removable plastic cones, removable bolts, special removable ties, tie wires or Series 300 stainless steel snap ties. For all other forms, either bolts or wires may be used. Use ties of such type that when forms are removed, no metal is closer than 40 mm from the finished concrete surface.

2.02 MIXES

A. Proportioning of Concrete

1. Comply with ACI Standard 211.1, OR BS 8110, Section 6, Para. 6.2.4. Assume full responsibility for the strength, consistency, water/cement ratio, and handling of concrete. Cement, fine aggregate and the various sizes of coarse aggregate shall be measured by weight.
2. Water/Cement Ratio: Comply with BS 8110, Section 6, Para. 6.2.4, OR ACI 301, Chapter 3, Para. 3.8, Method 1 or 2. The water/cement ratio of a batch of concrete shall not exceed the specified maximum value by more than 5% of that value. If a maximum water/cement ratio has been determined the ability to comply with that requirement at a suitable level of workability, shall be determined by trial mixes. Maximum water/cement ratio may be judged from workability tests and approved by the Engineer.
3. Cement Content: The cement content of any batch of concrete shall not be less than the specified minimum value minus 5% of that value, nor more than the specified maximum value plus 5% of that value. The cement content may be determined from samples representative of any batch of concrete provided suitable test is used to measure the cement content of fresh concrete to an accuracy of + 5% of the actual value with a confidence of 95% and approved by the Engineer. Table 6.1 of BS 8110 : Part 1 : 1985 gives the

minimum cement required when using a particular size of aggregate in a Portland cement concrete, to provide acceptable durability under appropriate conditions of exposure. The reduced minimum cement contents shall only be used when trial mixes have verified that concrete with a maximum free water/cement ratio not greater than that given for a particular condition can be consistently produced and it is suitable for the conditions of placing and compacting. The Engineer shall determine the degree of exposure to be adopted for mix design.

4. Requirements for Fresh Concrete: Workability of concrete shall be such that the concrete is suitable for the conditions of handling and placing so that after compaction it surrounds all reinforcement and completely fills the formwork. Workability shall be assessed by means of the slump test or compacting factor test. An acceptable value for the mean slump for each concrete mix shall be agreed with the Engineer and a value of 65 mm can be taken as a guide. Following are the limits of workability of concrete for these tests:

Slump ± 25mm or CF ± ± ±	03 where required value is 0.9 or more. .04 where the required value is less than 0.9 but more than 0.8. .05 where required value is 0.8 or less.

The amount of water shall be measured by volume or by weight. The batch weights of aggregates shall be adjusted to allow for a moisture content typical of the aggregates being used. The accuracy of the measuring equipment shall be within ± 3% of the quantity of cement, water or total aggregates being measured and within ± 5% of the quantity of any admixture being used.

All measuring equipment shall be maintained in a clean, serviceable condition. The mixer shall comply with the requirements of B.S. 1305 or B.S. 4251 where applicable. The mixing time shall be not less than that used by the manufacturer in assessing the mixer performance.

5. Adjustment to Mix Proportions: During production adjustments of mix proportions will be made in order to minimise the variability of strength and to approach more closely the target mean strength as approved by the Engineer. Such adjustments are regarded as part of the proper control of production but the specified limits of minimum cement content and maximum water/cement ratio shall be maintained. Such adjustments to mix proportions shall not be taken to imply any change to the current margin.

B. Classes of Concrete

1. Schedule of Concrete Types

CHARACTERISTIC CYLINDER STRENGTH (28 DAYS)	TYPE AND USE	CLASS
200 Kg/cm²	Blinding concrete.	C
20 Kg/cm²	Protective screed.	C
350 Kg/cm²	Cast-in-place reinforced concrete foundation	A
300 Kg/cm²	For slabs and beams a minimum cement content of 350 Kg/m3.	B
150 Kg/cm²	For Cyclopean concrete	C
400 Kg/cm²	Shear walls and columns with a minimum cement content of 450 Kg/m3.	A

General Important Notes

1. All classes of concrete are to be normal weight (2500 Kg/m3), well compacted and in accordance with these specifications.
2. The concrete must be vibrated during casting according to these specifications.
3. Particular care should be given to the placing of reinforcement, the mixing and casting of concrete, and to following the specifications for this trade. Concrete pouring shall be continuous between joints.
4. Cement used for vertical elements and slabs is Portland cement type I, and for foundations is Type V.
5. Cement of all concrete which is in contact with ground shall be Type V.

Part 3 - EXECUTION

3.01 FORMWORK

A. General

1. The responsibility for the safety and adequacy of the whole of the formwork shall rest entirely with the Contractor. Coordinate the work of all other trades affecting or affected by work of this Section.
2. Except when they are varied by the requirements of these Specifications, the requirements of the British Standard BS 8110 Section 6 shall form a binding part of these Specifications.
3. Give 24 hours minimum notice to the Engineer as to when formwork will be ready for inspection and allow sufficient time for inspection and adjustment.
4. Any work showing signs of damage through premature loading shall be demolished and reconstructed at the Contractor's expense.

B. Workmanship

1. Reference shall be made to BS 5975 and appendix "C" of the Concrete Society Technical Report No. 13, 'Formwork and the CIRIA Data Sheet' "Concrete Pressure on Formwork".
2. Except for areas having suspended false ceiling within the project, most of the structure is either exposed or receiving applied finish. Tolerances specified under this part are more stringent than those specified in BS 5606 or ACI 301.
3. Provide cambers as specified on drawings.
4. All formwork shall be constructed plumb, true, water and mortar tight, sufficiently rigid and strong to prevent sagging between supports and to maintain true position and shape during and after placing of concrete without bowing and distortion.
5. Exceptional care shall be taken to minimize fins, ridges, offsets, leaking of fins and other defects.
6. Only workmen experienced in formwork shall be used for this work.
7. Supports shall be designed to withstand the worst combination of self-weight and other loads including formwork, reinforcement, wet concrete, construction and wind loads together with all incidental dynamic effects caused by placing vibrating and compacting of concrete.
8. Deflection: The maximum permissible deflection under all loads shall not exceed 2 mm or 1/600 of the free span, whichever is less.
9. Forms for beams and girders shall be designed to permit removal of at least one side without shock to the partially set concrete and without disturbing the bottom portion of the forms or its supports.

10. Prefabricated formwork shall be used in strict accordance with manufacturer's printed instructions and approved shop drawings.
11. Provide 15 x 15 mm wrought hardwood fillet or other suitable material in the angles of the formwork as shown on Drawings or as required by the Engineer to provide chamfers in columns and beams and walls.
12. Anchor bolts, plates, sleeves, pipes, inserts, fixtures, electrical boxes, reinforcing steel, duct openings, conduits, etc., shall be installed as per Drawings. Ample time shall be allowed for the proper installation of such items. All steel items (other than reinforcement) embedded in concrete shall be hot-dipped galvanized.
13. Form Cleaning: All forms shall be thoroughly cleaned before placement of concrete and suitable temporary openings provided to permit removal of undesirable materials from the interior without disturbing the whole formwork. All surfaces in contact with concrete shall be wetted or treated with an approved form releasing agent before placing of reinforcement. All formwork shall be thoroughly cleaned of any old concrete or other deposit before re-use.
14. During concreting, formwork and supports shall be inspected by experienced workmen and any portion showing signs of sagging or displacement shall be rectified.
15. All formwork shall be inspected and approved by the Engineer. This approval, however, does not relieve the Contractor of any of his liabilities and responsibilities under the Contract.
16. The Contractor must allow in his Tender for cost of testing the type of form releasing agent he proposes to use.

3.02 REINFORCEMENT

A. General: Comply with B.S. 4449; B.S. 4461; B.S. 4482; B.S. 4483 OR ACI 301, Chapter 5, Paragraph 5.1, and ASTM A775.

B. Fixing
   1. Comply with BS 8110, Section 7, Para. 7.3 OR ACI Standard 301, Chapter 5, Para. 5.5. Reinforcement shall be secured against displacement outside the specified limits unless specified otherwise:
      a. Where reinforcement is located in relation to only one face of a member (e.g. a straight bar in a slab) the actual concrete cover shall not be more than the required cover shown on the Drawings plus:
         i) 5mm on bars up to and including 12mm size.
         ii) 10mm on bars over 12mm up to and including 25mm size.
         iii) 15mm on bars over 25mm size.
   2. Spacer chairs or other supports detailed on Shop Drawings, together with such other supports as may be necessary shall be used to maintain the reinforcement in its correct position. In a member where the nominal cover

is dimensioned to the links, spacers between the links and formwork shall be of the same dimension as the nominal cover.

3. Non-structural connections for the positioning of reinforcement shall be made with steel wire or tying devices. Care should be taken to ensure that the projection ends of ties or clips do not encroach into the concrete cover.
4. The position of reinforcement shall be checked before and during concreting, particular attention being paid to the position of top reinforcement in cantilever sections. Where there is delay in depositing concrete after the placement of the reinforcement the Engineer may require the Contractor to restore the reinforcement to a satisfactory condition and may require protection of same from further corrosion.
5. Surface Condition of Reinforcement: Concrete shall not be placed unless reinforcement is free from mud, oil, paint, retarders, loose rust, loose mill scale, grease or any other substance. Badly rusted or pitted reinforcement will be rejected. Mechanical brushes shall be used in cleaning steel bars.
6. All reinforcement shall be stored under cover to avoid contact with the ground, moisture, dust and salts and to avoid distortion once bent to shape. Improper storage will be sufficient cause for rejection of reinforcement.
7. Laps and Joints of Reinforcement: Laps and joints shall only be made by methods specified and at the positions shown on the Drawings or as agreed by the Engineer.
8. The splice lengths of all reinforcing bars which have to be spliced shall, unless otherwise shown on the drawings, be in conformity with the following:
    a. Deformed bars (60 x diameter) 600mm minimum.
    b. Fabric (175mm minimum, but overlap measured between outermost wires of each sheet not less than pitch of secondary reinforcement wires).
    c. Spliced bars are to be securely tied together.
9. Splices to be staggered to the approval of the Engineer and the fabric is to be securely tied layer to layer.
10. All reinforcement shall be placed accurately in position and securely fastened in place to prevent displacement during the placing of the concrete. Particular care shall be taken to ensure that the protective cover to reinforcement specified on the drawings is obtained by the use of approved plastic tipped steel chairs for lower reinforcement and cranked bars for upper reinforcement. All bars shall be securely tied together at every alternate intersection, or as approved by the Engineer.
11. Ends of bars which are left projecting for any period exceeding 4 weeks shall be painted with a heavy coat of neat cement grout which shall be removed prior to continuation of concreting.
12. Concrete cover to reinforcement shall be as shown on the drawings and the allowable tolerances shall be in accordance with BS 8110.
13. Tie wire shall be annealed iron wire not less than No. 16 gauge or approved fasteners, unless shown otherwise on the drawings.
14. Reinforcement that has in any way been previously used shall not be reused in the work.

15. Welding of Reinforcement: Welding on site shall be avoided if possible, but where suitable safeguards and techniques are employed and provided that the types of steel (including high yield steel to B.S. 4449 and B.S. 4461) have the required welding proportions, it may be undertaken. Generally, however, all welding shall be carried out under controlled conditions in a factory or workshop. The competence of the operators shall be demonstrated prior to and periodically during the welding operations.
16. Cutting and Bending Reinforcement: Reinforcement shall be cut and/or bent in accordance with B.S. 4466. Bends in reinforcement shall have a substantially constant curvature. Where the temperature of the steel is below 5`C, special precautions may be necessary such as reducing the speed of bending or, with the Engineer's approval, increasing the radius of bending. Where it is necessary to bend reinforcement projecting from concrete, care should be taken to ensure that the radius of bend is not less than that specified in B.S. 4466. The Engineer's written approval shall be obtained before cutting or heating any reinforcement detailed on the drawings. All reinforcement bars, coated and uncoated, shall be bent cold unless otherwise approved by the Engineer. Where it is necessary to reshape steel previously bent, this shall only be done with the Engineer's approval and each bar shall be inspected for signs of fracture.
17. Reinforcement (particularly grade 410/425) should not be subjected to mechanical damage or shock loading prior to embedment. It is permissible to bend grade 250 reinforcement projecting from concrete provided that care is taken to ensure that theradius of bend is not less than that specified in BS 4466. Grade 410/425 bars should not be rebent or straightened without the Engineer's approval.

3.03 MIXING CONCRETE

A. Ready Mixed Concrete
   1. Comply with ASTM C94.
   2. Add mixing water only at the Site (Important)
   3. Discharge the concrete completely at the Site within one hour after the introduction of the water to the aggregates. In hot weather reduce this time limit so that no stiffening of the concrete shall occur until after it has been placed.
   4. Begin the mixing operation within thirty minutes after the cement has been intermingled with the aggregates.

B. Batch Mixing at Site (if permitted by Governmental authority having jurisdiction)
   1. Comply with BS 8110, Section 6, OR ACI 301, Chapter 7, Paragraphs 7.2 and 7.5.
   2. Excessive mixing requiring the addition of water to preserve the required consistency will not be permitted. Mix concrete to a consistency which can be readily placed without segregation.

3. Where admixtures are specified, equip mixers with a device for measuring and dispensing the admixture.

C. Hand Mixed Concrete: This is not permitted.

D. Embedded Items
   1. Comply with ACI 301, Chapter 6, Paragraphs 6.4 and 6.5.
   2. Set anchorage devices by line and transit, and coordinate the locating of all anchorage devices to be set for the accommodation of the work of other trades.
   3. Locate anchor bolts and/or threaded type inserts and bars as shown on the Drawings and on shop drawings. Obtain necessary templates from the mechanical trades as required for the setting of anchor bolts and other items for mechanical equipment, as required.
   4. Assist other trades in the installation of piping, pipe sleeves, conduit and similar items where such items are to be installed in concrete. Provide frames to securely hold anchor bolts and anchorage devices in place during construction, and take care that no displacement occurs during the placing of concrete. Under this Section furnish and set items not furnished by other trades using approved standard type items suitable for their intended purpose.

3.04 PLACING CONCRETE

A. Comply with ACI Standard 301, Chapter 8, Para. 8.1 for preparation before placing and with BS 8110, Section 6, Para 6.5 and 6.8. Notify the Engineer 24 hours before each placement so that the forms and reinforcement may be examined. Do not place concrete until inspection has been made or waived.

B. Concrete shall not be mixed or placed at shade air temperature below 2°C on a rising thermometer, or at a shade air temperature below 3°C on a falling thermometer. When the shade air temperature is 32°C and rising, special precautions shall be taken during concrete operations, such as shading of the aggregates, formwork and plant, cooling of the mixing water or other methods approved by the Engineer so that the temperature of the concrete when placed shall not exceed 30°C. The temperature of the concrete can be reduced by cooling the water and the aggregate.

C. Fresh concrete placed at these temperatures shall be shaded from the direct rays of the sun to the satisfaction of the Engineer for a period of 24 hours. Concrete is not to be mixed and placed when the shade air temperature is 38ºC or above.

D. Before concrete is placed, clean mixing and conveying equipment from hardened concrete and foreign matter. Check forms for construction and detail. Secure reinforcement sleeves and inserts in correct position. Forms shall be free of water

and all debris. Sprinkle with water any semi-porous sub-grade to eliminate suction. Water shall be removed from excavation before depositing concrete, such water shall not be allowed to wash over newly formed concrete.

E. Comply with ACI Standard 301, Chapter 8, Para 8.2 for conveying concrete. Concrete shall be transported from the mixer to the formwork as rapidly as practicable by methods which will prevent the segregation or loss of any of the ingredients and maintain the required workability. Concrete shall be placed and compacted without addition of water. Care shall be taken to avoid displacement of reinforcement or movement of formwork and damage to faces of formwork.

F. Care shall be exercised to prevent segregation of concrete and to prevent splashing the forms while placing concrete. Concrete shall be placed through canvas tremie tubes only equipped with suitable hopper heads. Chutes or trunking shall be of variable lengths so that the free fall of the concrete from the end shall not exceed one metre and a sufficient number shall be used to ensure that the concrete surface is approximately level at all times. Where alternative provisions can be made, which are acceptable to the Engineer, then low slump concrete can be dropped vertically through greater heights than one metre.

G. Concrete shall be thoroughly compacted by vibration, pressure, shock or other means during the operation of placing and thoroughly worked around the reinforcement, around embedded fixtures and into corners of the formwork to form a solid mass free from voids and which will have required surface finish when formwork is removed. Vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and there is no secretion of ingredients. Care shall be taken that the vibrator is not used any closer than 75 mm from the formed surface. Where permanent precast concrete formwork is used in the structure, its energy absorption should be taken into account when deciding on the method of vibration to be used and the Engineer’s prior approval shall be obtained in respect thereof.

H. Concrete which has achieved its initial set and cannot be properly compacted shall not be placed in the forms.

I. Concrete topping: Before application the surfaces shall be thoroughly wetted and brushed over with a coat of neat cement grout. The topping shall be placed before the grout has started to set.

J. Slope surfaces to drains where indicated. Slope shall be as indicated on Drawings.

3.05 CURING

A. General

1. Comply with BS 8110, Section 6, Para. 6.6 and 6.8 and ACI Standard 301, Chapter 12.
2. The methods of curing and their duration shall be such that the concrete will have satisfactory durability and strength, and the member will suffer a minimum distortion, be free of excessive efflorescence and will not cause by its shrinkage, undue cracking in the structure. Insulate the concrete so that it is maintained at a suitable temperature and prevent excessive moisture loss from the concrete. Curing shall be appropriate to different members and products. Where necessary special care shall be taken to ensure that similar components are cured under the same conditions.
3. Curing shall be promptly commenced, be total in coverage and continued without interruption.

B. Curing Methods

1. Ponding with Water: Effective for flat surfaces. Curing water shall not be more than 11°C (52°F) cooler than the concrete and shall be free of substances that may stain or discolour concrete.
2. Saturated Material: Saturated material shall be held in close contact with concrete surfaces and maintained in moist condition so that a film of water remains on the concrete surface throughout the curing period. Saturated materials shall be kept wet for a minimum of seven days after stripping.
3. Intermittent Spraying with Water: Care shall be taken that newly finished concrete is not damaged by water erosion. If spraying is done at intervals, concrete surfaces shall not dry out between applications of water.
4. Top of columns and walls shall be cured after initial setting. As soon as formwork is loosened water curing shall be applied to sides of columns and walls, and shall continue uninterrupted for a minimum of seven days.
5. Slabs and flat surfaces shall be cured by flooding. Flat concrete surfaces shall be covered immediately after concrete is placed, tamped and levelled, with polyethelene sheet and flooded with water as soon as initial hardening of concrete occurs. Covering surface shall follow progress of concrete placement until the whole surface is covered and flooded. Polyethelene sheet may be removed after 24 hours and regular flooding maintained for a minimum of 7 days.
6. Use special thermometers of sufficient length of stem to monitor the concrete temperature of the raft foundation slab as soon as concrete is placed to the required level. Monitor temperature of concrete for 7 days and provide the Engineer with daily records.
7. Curing Compounds
    a. Where there is lack of adequate supplies of clean water, curing membrane solution shall be applied at the coverage rate recommended by the

manufacturer (two coats, one at right angles to the other), immediately after placing concrete.

b. Concrete surfaces shall be damp when the coating is applied. Curing compounds shall not be used if bond is necessary such as in base slab of two course floor.
c. Conventional curing compounds shall not be used if a special finish is to be applied. In such cases, special resin solutions that do not affect adhesion of finishes may be used as approved by the Engineer.

C. Curing Periods: Seven (7) days is the minimum curing period for all cast-in-place concrete. At the discretion of the Engineer the curing period may be extended.

3.06 STRIKING OF FORMWORK

A. Comply with BS 8110:85, Section 6, Para. 6.9.3 OR ACI 301, Chapter 4, Para. 4.5.

B. Do not remove forms or supports until the concrete has thoroughly hardened and has attained sufficient strength to support its own weight and construction live loads to be placed thereon, without damage to the structure. Do not disturb forms or supports until the concrete has attained at least 40% of design strength for side forms and 80% of design strength for bottom forms. Be responsible for proper form removal and replace any work damaged due to inadequate maintenance or improper or premature form removal.

C. The following shall be the minimum periods before striking formwork, unless otherwise directed by the Engineer:
   1. Vertical formwork to columns, walls and large beams ... 24 Hours
   2. Beam sides ... 24 Hours
   3. Beam soffits formwork ... 15 days
   4. Props to beams ... 21 days
   5. Soffit formwork to slab ... 6 days
   6. Props to slab ... 15 days

D. The removal time may be decreased with the Engineer’s approval where surface temperature of concrete is 16ºC and above; refer to Table 6.6, Section 6 of BS 8110, Part 1.

E. Protect the newly placed concrete from high and low temperatures using suitable means of insulation for the duration of the curing.

F. Care shall be exercised in form removal to prevent chipping of corners and other damage. Experienced foremen shall supervise form removal.

G. Removal of bottom form linings may be permitted, provided the removal is planned sequentially so that props are replaced as each lining is removed, and work is carried out during the presence of Engineer.

H. No new permanent structure shall be constructed on any part of the erected structure while the latter is still supported by formwork unless walls are built above another wall carried on a properly supported base. This requirement does not prohibit the use of props to take the load of more than one level of framing.

3.07 TOLERANCES

A. Comply with B.S. 5606 OR ASTM E1155, Standard test method for determining floor flatness and levelness, unless noted117-81, Part 5, unless noted otherwise.

3.08 CLEANING FINISHED EXPOSED CONCRETE SURFACES

A. Efflorescence, stains, oils, grease or any unsightly accumulation of foreign materials that are visible on the exposed exterior and/or interior surface of finished concrete, shall be removed. Such action may cover all exposed concrete or when irregular lapping can be avoided, only such parts as are affected by the stains or other unsightly appearances. No such remedial action shall be taken without the approval of the Engineer.

3.09 PATCHING

A. Comply with ACI 301, Chapter 9.

3.10 FINISHING

A. General Requirements for Flatwork: Strike off top surfaces of finished fill and monolithic slabs true and level within a tolerance of 3 mm in 3 metres and measured with a 3 metre straight edge placed in any direction at any location.

B. Monolithic Floor Finish: Level surface and remove excess laitance by tamping, screeding, and preliminary wood floating. When the slab has hardened sufficiently so that water and fine material will not be worked to the top, compact the surface with motor-driven floats of the disc type and trowel smooth with two steel troweling operations. Do the second troweling after the concrete has become so hard that no mortar will adhere to the edge of the trowel. Leave floors with a smooth, hard finish free of blemishes and true to a maximum tolerance of 3mm in 3 metres. Monolithically finish surfaces scheduled to receive the following:
   1. Hardener and Sealer.

C. Motor Float Finish: Level surface and remove excess laitance by tamping, screeding, and preliminary wood floating. When the slab has hardened sufficiently so that water and fine material will not be worked to the top, compact the surface with motor-driven floats of the disc type. Leave floors/ roofs

with a smooth finish and true to a maximum tolerance of 3mm in 3 metres. Motor float finish surfaces scheduled to receive the following:

1. Membrane Waterproofing.

D. Rough Slab Finish: Tamp the concrete using special tools to force the aggregate away from the surface, then screed with straight edges to produce a reasonably true and uniform surface. Rough slab finish surfaces scheduled to receive the following:

1. Floor beds.

E. Wood Float Finish: Tamp the concrete using special tools to force aggregate away from the surface, then screed with straight edges to bring surfaces to the required lines. While the concrete is still green, wood float to a true and uniform plane to a 3mm in 3m tolerance with no coarse aggregate visible and apply a medium stiff broom finish striated uniformly at right angles to traffic pattern and in the direction indicated. Apply hardener and sealer to the following:

1. Driveway, Ramps and Parking.

F. Fair Face Finish: Interior Exposed Concrete Surfaces of Slab, Beams, Columns and Walls. Unless otherwise shown, leave a smooth fair face finish, even-textured and free of blemishes. Repair or replace defective areas, as directed. As soon as the face forms are removed, remove all fins and other projections carefully, level offsets and grind where necessary. Repairing, replacing and pointing and filling voids shall be done to the Engineer’s satisfaction. Patch as specified under paragraph “Patching”. Refer to architectural drawings to determine surfaces scheduled to receive paint.

Metal Fabrication

SECTION 055000
METAL FABRICATIONS

Part 1 - GENERAL

1.01 SUMMARY

A. Provide miscellaneous metal work shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
   1. Steel access ladders
   2. Ladder safety cages
   3. Structural steel door frames
   4. Support angles for elevator door sills
   5. Steel framing and supports for overhead coiling doors and grilles.
   6. Equipment supports.
   7. Safety nosings
   8. Steel framing and support for mechanical and electrical equipment
   9. Loose bearing and leveling plates for applications where they are not specified in other Sections.
   10. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections

B. Related Sections include the following:
   1. Division 05 Section “Structural Steel” for structural steel framing for elevator divider beams and guide rail supports.
   2. Division 05 Section “Pipe and Tube Railings” for interior and exterior steel pipe rails.
   3. Division 05 Section “Metal Gratings” for steel gratings.
   4. Division 06 Section “Miscellaneous Rough Carpentry” for wood blocking attached to miscellaneous metals.
   5. Division 09 Section “Painting” for field finishing of miscellaneous metal materials.
   6. Division 11 Section “Loading Dock Equipment” for loading dock edge angles.

1.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.03 SUBMITTALS

A. Product Data: Provide list of items proposed to be provided under this Section. Include manufacturer's specifications, material descriptions, and other data needed to demonstrate compliance with specified requirements for each factory-fabricated product including brackets, and accessories.

B. Shop Drawings: Show fabrication and installation details for metal fabrications. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
    1. Provide templates for anchors and bolts specified for installation under other Sections.
    2. Shop drawings and calculations for guardrails indicated to comply with certain design loading, shall be prepared by and bear the stamp of a qualified structural engineer.

1.04 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Qualify welding processes and welding operators in accordance with American Welding Society Code [AWS] "Standard Qualification Procedures."

C. Professional Engineer Qualifications: A professional engineer who is experienced in providing engineering services for systems of the kind indicated.

1.05 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by taking accurate field measurements before fabrication and indicate measurements on Shop Drawings.
    1. Allow for field cutting and fitting where taking field measurements before fabrication is not possible.
    2. Do not field cut or fit items which have been hot-dip galvanized after fabrication.

1.06 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

Part 2 - PRODUCTS

2.01 MATERIALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, limit materials to those which are free from surface blemishes, pitting, rolled trade names, and roughness.

B. Comply with the following standards, as pertinent:
- ASTM A-572 Plates/Rolled Sections
- ASTM A-607 GR. 50 Purlins
- H.T. Bolts GR. (8.8)
- ASTM A36 Rods
- Electrodes E690
- Anchor Rods Gr (4.6)
- All flanges are groove welded full penetration
- WEBS are fillet welded both sides
- Contractor shall provide full calculation and shop drawing by a specialized company before erection

Notes:
- Contractor shall provide full calculation and shop drawing by a specialized company before erection

C. Fasteners: Provide fasteners of type, grade, and class required for the particular use. Provide hot-dip galvanized fasteners for connecting to galvanized steel. Comply with the following standards as pertinent.

1. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Grade 8.8; with hex nuts, ASTM A 325; and, where indicated, flat washers.
2. Anchor Bolts: ASTM A325, Grade 4.6, of dimensions indicated; with nuts, ASTM A 325; and, where indicated, flat washers.
    a. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
3. Eyebolts: ASTM A 489.
4. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
5. Lag Screws: ASME B18.2.1.
6. Wood Screws: Flat head, ASME B18.6.1.
7. Plain Washers: Round, ASME B18.22.1.
8. Lock Washers: Helical, spring type, ASME B18.21.1.
9. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing

according to ASTM E 488, conducted by a qualified independent testing agency.

10. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
11. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
    a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
    b. Material for Exterior Locations: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.
12. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o. c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

D. Shop Paint: shall be Modified Alkyd primer equal to Tnemec No. 10-99G Green Metal Primer, Dupont 681 FD Primer, or Architect approved substitute.
    1. All steel members, except galvanized items, after they are prepared, shall be prime painted before shipping. All surfaces shall be prime painted, except machined surfaces, surfaces which are to be welded and surfaces to be encased in concrete. Primer Paint shall be applied thoroughly and evenly on the surfaces and worked into the joints and other open surfaces. Surfaces inaccessible after assembly shall be given two coats. Dry film thickness per coat of prime paint shall be not less than 2.4 mils.

    2. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first.

E. Galvanizing: For the purposes of establishing a standard of quality and performance, provide factory-applied metal coatings as specified by Duncan Galvanizing, Everett, MA 02149, (617) 389-8440.
    1. Hot-Dip Galvanizing: Provide coating for iron and steel fabrications applied by the hot-dip process, Duragalv by Duncan Galvanizing. Comply with ASTM A123 for fabricated products and ASTM A153 for hardware. Provide thickness of galvanizing specified in referenced standards. The galvanizing bath shall contain high grade zinc.

2.02 OTHER MATERIALS

A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor, subject to the approval of the Architect.

B. Grout: Pre-mixed, non-staining, non-corrosive, non-shrink, non-metallic cement based grout complying with ASTM C1107 "Standard Specification for Packaged Dry Hydraulic Grout - Non Shrink"; Five Star Grout or Architect approved substitute.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.03 FABRICATION, GENERAL

A. Except as otherwise shown on the Drawings or the approved Shop Drawings, use materials of size, thickness, and type required to produce reasonable strength and durability in the work of this Section.

B. Fabricate with accurate angles and surfaces which are true to the required lines and levels. Fabricate work with uniform, hairline tight joints. Form welded joints and seams continuously and grind flush and smooth to be invisible after painting. Use concealed fasteners wherever possible, for exposed fasteners, use hex head bolts or Phillips head machine screws. Locate joints where least conspicuous.

C. Shop fabricate work to the greatest extent possible. Clearly label pieces in shop to facilitate field assembly.

D. Shear and punch metals cleanly and accurately. Remove all burrs. Ease exposed edges to a radius of approximately 1/32-inch, unless otherwise indicated.

E. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Weld corners and seams continuously to comply with the following:
    1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    2. Obtain fusion without undercut or overlap.
    3. Remove welding flux immediately.
    4. At exposed connections, finish exposed welds and surfaces to comply with NOMMA’s “Voluntary Joint Finish Standards” for Type 2 welds: completely sanded joint, some undercutting and pinholes okay.
    5. Utilize welded joints, prequalified by AWS for the procedure and position used for all partial and complete joint penetration welds.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
    1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o. c., unless otherwise indicated.

J. Toilet partitions: Fabricate support system to carry the entire load of toilet partitions to the structure above without transferring any horizontal or vertical load to ceiling system. Provide frequently spaced holes for multiple adjustment. Provide diagonal braces. Unistrut type members are acceptable.

2.04 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
    1. Fabricate units from slotted channel framing where indicated.
    2. Furnish inserts for units installed after concrete is placed.

C. Galvanize exterior miscellaneous framing and supports and interior miscellaneous framing and supports where indicated.

D. Prime interior miscellaneous framing and supports with specified primer where galvanizing is not indicated.

E. All manufacturing details should comply with all specification and the last version of AISC and AWS. Contractor to submit complete shop drawings

F. All structural elements to comply with ASTM A572

G. All bolts to be grade (8.8)

H. All joints if approved, to be slip critical and bolt fixing by automatic wrench
And by progressing force. As per AISC

I. All fixing bolts to be BS3692 or ASTM-325

J. All welding to by experts

K. All welding rods to be A 5.1 AWS E7018 for soft steel and AWS A5.5 for hard steel and ARC electrical welding
And all members to have a tension force 72 lb/inch^2 (E6018) or approved equal.

L. All fixing bolts to be properly fixed

M. All junctions to match AISC

N. All steel members to be dust free.

2.05 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Prime plates with specified primer, except galvanized plates left exposed to weather or used in exterior walls.

2.06 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.07 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Shop Paint: All steel members, except galvanized items, after they are prepared, shall be prime painted before shipping. All surfaces shall be prime painted, except machined surfaces, surfaces which are to be welded and surfaces to be encased in concrete. Primer Paint shall be applied thoroughly and evenly on the surfaces and worked into the joints and other open surfaces. Surfaces inaccessible after assembly shall be given two coats. Dry film thickness per coat of prime paint shall be not less than 2.4 mils. 1. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first.

D. Galvanizing: Galvanize materials in accordance with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products. Galvanizing shall

provide an acceptable substrate for applied coatings. The dry kettle process shall be used to eliminate any flux inclusions on the surface of the galvanized material.

1. Prior to galvanizing, the steel shall be immersed in a pre flux solution (zinc ammonium chloride.
2. The wet kettle process shall be prohibited.

Part 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required for installing metal fabrications.

B. Set work accurately into position, plumb, level, true, and free from rack. Anchor firmly into position. Comply with requirements, manufacturers' written instructions and requirements indicated on Shop Drawings.

C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

D. Where field welding is required, comply with AWS recommended procedures of manual shielded metal-arc welding for appearance and quality of weld and for methods to be used in correcting welding work and the following:
    1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    2. Obtain fusion without undercut or overlap.
    3. Remove welding flux immediately.
    4. At exposed connections, finish exposed welds and surfaces to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 2 welds: completely sanded joint, some undercutting and pinholes okay.

    5. Comply with AWS D1.1 specifications. Utilize prequalified welded joints appropriate for processes and positions used for all full and partial joint penetration welds.

E. Fastening to In-place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

F. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.03 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for toilet partitions, cabinets, and equipment securely to and rigidly brace from building structure.

C. Support steel girders on concrete, steel columns, or other structural steel supports. Secure girders with anchor bolts embedded in concrete, with bolts through top plates of pipe columns, or connect to structural steel supports by bolting or welding.
    1. Where grout space under bearing plates is indicated for girders supported on concrete, install as specified in "Installing Bearing and Leveling Plates" Article.
    2. Grout base plates of columns supporting steel girders after girders are installed and leveled.

3.04 INSTALLING SAFETY NOSINGS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps, align nosings flush with riser faces and level with tread surfaces.

3.05 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
    1. Use nonmetallic, non-shrink grout.
    2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.06 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the specified touch-up repair primer by brush or spray to provide a minimum 2.4-mil dry film thickness to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. All exterior structural steel associated with PV module supports, walkways, handrails, and equipment frames shall be hot-dip galvanized after fabrication to ISO 1461, minimum average coating thickness 85 µm. Use stainless-steel fasteners (A4/AISI 316) with isolating washers. Field cuts shall be repaired with zinc-rich paint to ASTM A780; cosmetic aluminum-look paints are not acceptable."

C. Touch-Up and Repair: For damaged and field-welded metal coated surfaces, clean welds, bolted connections and abraded areas.
    1. For galvanized surfaces, apply organic zinc repair paint complying with requirements of ASTM A 780, modified to 95 percent zinc in dry film. Galvanizing repair paint shall have 95 percent zinc by weight, ZiRP by Duncan Galvanizing. Thickness of applied galvanizing repair paint shall be not less than coating thickness required by ASTM A 123 or A 153 as applicable. Touch-up of galvanized surfaces with silver paint, brite paint, or aluminum paints is not acceptable.