NEW BOYS HOSTEL BLOCK B&C, IBA MAIN CAMPUS, KARACHI

VOLUME 3
SPECIFICATIONS
(CIVIL WORKS)

SPECIFICATIONS

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SECTION A - WORK RESTRICTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1.2 USE OF SITE

A. **General:** The Contractor shall have full use of the site of the works, during construction period. However, the Contractor's use of site is limited only by the Employer's right to perform work or to retain other Contractors to do so.

B. **Use of Site:** Limit work and activities to the area of the Site as defined on Drawings in areas indicated. Do not disturb areas outside the Site or in which the work is indicated.

1. Limits: Confine constructions operations to areas where work is permitted.

2. The Employer Occupancy: Allow for the Employer occupancy of Site.

3. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to the Employer, the Engineer and their employees, other Contractors engaged in work on the Site and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.

    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.3 OCCUPANCY REQUIREMENTS

A. **Partial Employer Occupancy:** The Employer reserves the right to occupy and to place and install equipment in completed areas of the Site, before substantial completion, provided such occupancy does not interfere with the Contractor's completion of the Works. Such placement of equipment and partial occupancy shall not, by itself, constitute completion or acceptance, nor Taking-Over of any part of the Works.

PART 2 - PRODUCTS (Not Used)

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SECTION B - QUALITY ASSURANCE/ QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1.2 QUALITY ASSURANCE PROGRAM

A. Provide and maintain an effective Quality Assurance Program that complies with Clauses 36, 37, 38 and 39 entitled "Materials, Plant and Workmanship" of the Part I, General Conditions of the Contract.

1.3 SCOPE OF PROGRAM

A. The Contractor shall establish a Quality Assurance Program to perform sufficient inspection and tests of all items of work, including that of his suppliers and subcontractors, to insure conformance to applicable Technical Specifications and Drawings with respect to the materials, workmanship, construction, finish, functional performance, and identification.

1.4 PLAN DEFINITION

A. **The PQAP (Project Quality Assurance Program):** This Plan is the means to ensure that construction complies with the requirements of the Contract Documents. The CQAP shall be adequate to cover all construction operations, including both on-site and off-site fabrication and installation works by subcontractors and will be keyed to the proposed Contract Schedule. The PQAP shall include as a minimum, at least three phases of inspection for all definable phases of works which are subsequently described in paragraphs 1.4.B, 1.4.C, 1.4.D.

B. **Preparatory Inspection:** This inspection shall be performed prior to beginning any work on any activity on any definable phase of works and as shown in the Contract Schedule. It shall include a review of contract requirements; a check to assure that all materials and/or equipment have been tested, submitted, and approved by the Engineer; a check to assure that provisions have been made to provide required control testing; and plan mock-ups when appropriate; examination of work area to ascertain that all preliminary work has been completed; and a physical examination of materials and equipment to assure that they conform to approved shop drawings or submittal data and that all materials and/or equipment are on hand. The Engineer shall be notified at least twenty four (24) hours in advance of the preparatory inspections and such inspection shall be made a matter of record in the Contractor's Quality Control Reports as required by paragraph 3.3.

C. **Initial Inspection:** This inspection shall be performed as shown in the Contract Schedule. This inspection shall occur as soon as a representative portion of the particular phase of construction has been accomplished. This shall establish the acceptable standard of workmanship, including a review of control testing for compliance with contract requirements, review of mock-up, use of defective or damaged materials, omissions, and dimensional requirements. The Engineer shall be notified at least twenty four (24) hours in advance of the initial inspection and such inspection shall be made a matter of record in the Quality Control Reports as required by paragraph 3.3.

D. **Follow-up Inspections:** Inspections shall be performed daily to assure continuing compliance with Contract requirements, including control testing, until completion of the particular phase of construction. Such inspections shall be made a matter of record in the Quality Control Reports as required by paragraph 3.3.

1.5 CONDITIONS OF PROJECT QUALITY ASSURANCE PROGRAM (PQAP)

A. Furnish to the Engineer, a PQAP which shall include the personnel, instructions, procedures, records to be used, document controls and quality assurance overview. This document will include as a minimum:

a. The Quality Control Organization (Chart) including major reporting lines and relationships.

b. Reporting relationships within and external to organization. Duties and responsibilities within the said organization shall be stated.

c. The name of the Quality Control Manager (QCM). This individual shall report directly to senior management, independent of manufacturing/ construction.

d. Names and Qualifications of Quality Control Personnel.

e. Authority and area of responsibilities of Quality Control Personnel.

f. An explanation as to how the Quality Control organization relates to other staff elements as regards Shop drawing submittals, As-Built drawings, revisions to the contract and safety.

g. Methods proposed to control the use of the various design documents, shop drawings, procedures, etc. to assure that only the latest reviewed documents are used and are distributed to the individuals performing the Work. Recall of documents which have been superseded or revised shall be implemented. Describe the process used to determine what submittals are required by the Contract and the system used to track these submittals and their current status.

h. A narrative discussion of how the Quality Control staff will accomplish the tasks assigned to quality control.

i. A copy of a letter of direction to each representative responsible for Quality Control, outlining his duties and responsibility and signed by a responsible officer.

j. Identification and description of all mock-up items.

k. Methods for accomplishing quality control inspections addressing the how, what, where, when and why of these inspections, including that for subcontractor's work (see paragraph 3.).

l. Method of documenting quality control operations, inspections and testing. This shall include how various records originated and maintained, received, filed, protected, and authenticated. Quality Records required for submittal to the Engineer shall be described.

m. Detailed listing by Specification Section and paragraph designating all QC requirements and tests to be performed and their frequency. Further indicate which tests will be performed by technicians or by an approved testing laboratory.

n. Methods to be employed when any Work is found not to meet Technical Specifications and the means to be implemented to document the items (non-conformance reports) and provide resolution.

o. A matrix of all Contract and Technical Specification requirements to enable monitoring of all items from start until acceptance and completion. This is to facilitate Contract close-out.

B. To facilitate contract management and project administration the Contractor shall acquire and implement the Primavera Expedition Project Control system. The Contractor shall provide information on tracking and control of documentation extracted from the System as and when required by either the employer or the Engineer.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Prior to submittal of the PQAP for acceptance, meet with the Engineer or his representative and discuss the PQAP. The meeting shall develop mutual understanding relative to details of the system, including the forms to be used for recording the Quality Control operations, inspection, administration of the program, and the interrelationship and the Engineer's inspection. Requirements for Hold Point Release sign offs on Quality Control checklists/ inspection sheets by the Engineer shall also be discussed and established.

3.2 QUALITY CONTROL ORGANIZATION

A. The PQAP shall be implemented by the establishment of the Quality Control Organization whose sole duty will be to ensure conformance to the Contract of all QA/QC activities.

B. Quality Control Manager (QCM) must be an individual with demonstrated experience implementing a QC program and supervising Inspectors.

1. This experience shall include at least five (5) years of Quality Control (QC) background in any combination of the following areas:

   a. Field inspection.

   b. Construction phase experience relevant to the scope of work.

   c. Previous experience as a Quality Control Manager.

   d. Fabrication/Manufacturing experience.

2. In addition, the QCM shall have the following managerial experience:

   a. Supervised at least two (2) people.

   b. Experience on a government regulated project.

   c. Implemented a Quality Control (QC) program.

   d. Experience on a comparably sized project of similar complexity.

3. Submit the résumé of proposed QCM for acceptance by the Engineer. If, for

any reason, the QCM is replaced, the resume of the proposed replacement QCM shall be submitted and accepted by the Engineer prior the replacement taking effect.

4. Due to the complexity and nature of this Contract a full time QCM is required.

C. Quality Control Organization shall be sufficiently staffed to perform the following tasks:

1. Conduct phased inspections (Preparatory, Initial and Follow-up) in accordance with paragraph herein before.

2. Perform all testing required under the Technical Specifications, including all listed Codes and Standards.

3. Prepare daily and monthly QC reports in accordance with paragraph 3.3 hereinafter.

4. Review and endorse all shop drawing submittals for compliance with Contract requirements prior to submission to the Engineer.

5. Inspect materials as they are delivered on site to ensure compliance with reviewed shop drawings and contract specifications.

6. Conduct off-site inspections of supplies and services to be incorporated into the work. Provide monthly report of off-site QC activities.

7. Maintain record of all QC activities. These records shall be available for the Engineer's use.

D. Where applicable and as a minimum, the Quality Control staff shall include the following suitably qualified personnel:

1. Structural Quality Control Inspector

2. Architectural Quality Control Inspector

E. If at any time during the contract period the Engineer determines the Contractor's Quality Control staff is not capable of performing all the tasks listed above, then the Engineer may direct to revise and/or supplement the present organization structure at own cost.

3.3 QUALITY CONTROL REPORTS

A. **Daily Quality Control Report:** Submit a daily Quality Control Report. The report shall contain a record of inspections and tests for all work accomplished subsequent to the previous report and shall include the following information:

1. Phase(s) of construction underway during the time frame of the report. (i.e. earthwork, concrete work, structural steel erection, mechanical and electrical installations, architectural finishes etc.)

2. Phase Inspection (preparatory, initial or follow-up), phase of construction and location of inspections and/or tests that were made.

3. Results of inspection, including nature of deficiencies observed and corrective actions taken or to be taken.

4. Report of tests performed, including those specified, with the results of the tests, including failures and remedial action to be taken. Test results, including all computations shall be attached to the report form. Where test results cannot be completed by the time the report is submitted, a notation shall be made that the test was performed and the approximate date test results will be available. Delayed test results shall be submitted with the report form on the date received.

5. Results of inspection of materials and equipment upon arrival at the site and prior to incorporation into the work for compliance with submittal approvals, damage and proper storage.

6. Offsite QA/QC activities.

7. Instructions received from the Engineer.

8. All non-conformances, either in tests or inspections, shall be specifically listed under a separate heading.

9. In all cases, the report must be verified and signed by QCM. The verification is to contain the statement that all supplies and materials incorporated in the work are in compliance with the Contract except as noted.

B. **Monthly Quality Control Report:** Submit a Monthly Quality Control Report. This report shall consist of an executive summary of all QA/QC activities executed in the previous month. The report shall contain the following information:

1. Phase(s) of construction underway during the time frame of the report. (i.e. earthwork, concrete work, structural steel erection, mechanical and electrical installations, architectural finishes etc.)

2. Confirmation that all necessary Quality Control testing has been performed in accordance with the Technical Specifications and other Contract documents, with respect to quantity and quality.

3. Summary of the tests performed during the month, including number passing and failing.

4. Summary of all non-conformances, including actions taken or actions proposed.

5. Details of significant trends in test results.

6. In all cases, the report must be verified and signed by QCM. The verification is to contain the statement that all supplies and materials incorporated in the work are in compliance with the Contract except as noted.

3.4 CHANGES TO QUALITY ASSURANCE PROGRAM

A. Notify the Engineer or his authorized representative in writing of any proposed change to the Contractor's Quality Assurance Program. Any proposed changes must not be implemented until prior approval has been received from the Engineer.

PART C – CONSTRUCTION PROGRESS DOCUMENTATION

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1. Refer to Conditions of Contract and Agreement for definitions and specific dates of Contract Time.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Preliminary Construction Programme.
2. Construction Programme.
3. Submittals Schedule.
4. Daily construction reports.
5. Monthly progress reports.
6. Material location reports.
7. Field condition reports.
8. Accident reports.
9. Special reports.
10. Wage book and time sheet records.

1.3 SUBMITTALS

A. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified.

B. **Submittals Schedule:** Submit three copies of schedule. Arrange the following information in a tabular format, identifying corresponding programme activity or event number for each scheduled date:

1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal type and category (action or informational).
4. Name of manufacturer and/or subcontractor, as applicable.
5. Description of the work covered.
6. Scheduled date for the Engineer's final release or approval.

7. Scheduled dates for Purchase Order and first delivery to Project site.

8. Scheduled date for commencement of installation.

C. **Update Submittals Schedules:** Submit two copies of update schedules.

D. **Construction Programme:** Submit two blue- or black-line print copies of programme, large enough to show entire programme for entire construction period. In title block indicate "Initial", "Revised" or "Update" as applicable, and date of issue.

1. Submit an electronic copy of programme, using software indicated, on CD-ROM labeled to comply with requirements for submittals. Indicate type of programme (Initial, Revised or Update) and date on label.

E. **CPM Reports:** Concurrent with each CPM schedule submittal, submit three printed copies of each of the following corresponding, computer-generated reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.

1. Activity Report: List of all activities sorted by major area, then by activity number and then early start date, or actual start date if known.

2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.

3. Total Float Report: List of all activities sorted in ascending order of total float.

4. Resource Allocation and Loading Report: List of all resources allocated to schedule activities, sorted in ascending order by activity number and then early start date, or actual start date if known, including but not necessarily limited to:

   a. Number and trade classification of workmen.

   b. Quantities of materials and products.

   c. The Contractor's Equipment.

5. Monetary Value Summaries.

F. **Construction Photographs:** Submit two (2) print sets of each photographic view within five (5) days of taking photographs.

1. Format: 200 x 250-mm smooth-surface matte colour prints on single-weight commercial-grade stock, enclosed back to back in clear plastic sleeves that are punched for standard ring binder.

2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:

   a. Name of Project.

   b. Name of the Employer.

   c. Name of the Engineer.

   d. Name of the Contractor.

e. Date photograph was taken.

f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction, as applicable.

3. Negatives: Submit a complete set of corresponding photographic negatives, in protective envelopes, with each submittal of prints. Identify date photographs were taken.

a. Negatives shall be for the Employer's free and unrestricted use.

G. Daily Construction Reports: Submit two (2) copies daily, and no later than 4:00 pm on the day immediately following date of report.

H. **Monthly Progress Reports:** Submit two (2) copies at monthly intervals. Report progress status coincidental with cutoff date associated with each Monthly Statement payment application.

1. Submit an electronic copy, using Microsoft Office software, on 90-mm diskette(s) labeled to comply with requirements for submittals.

I. **Material Location Reports:** Submit two (2) copies at weekly intervals.

J. **Field Condition Reports:** Submit two (2) copies at time of discovery of differing conditions.

K. **Accident Reports:** Submit two (2) copies at time of accident event.

L. **Special Reports:** Submit two copies at time of unusual event.

1.4 REPORTS

A. **Daily Construction Reports:** Prepare a daily construction report, recording the information concerning events at Project site:

B. **Monthly Progress Reports:** Prepare and submit monthly progress reports, summarizing activities, achievements, advancements and significant events at Site in month preceding, and reporting current progress status of Works.

a. **Material Location Reports:** At intervals indicated, prepare and submit a comprehensive listing, in tabular form, of materials delivered to and stored at Site. List shall be cumulative, showing materials previously reported plus items delivered since previous report.

D. **Field Condition Reports:** Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Include a detailed description of the differing conditions, together with a request for instruction, if applicable.

E. **Accident Reports:** On the occurrence of any accident which causes personal injury or damage to the Works or any other property, prepare a detailed accident report and submit directly to the Engineer within one day of occurrence. Include details of date and time, location, prevailing conditions, chain of events and causes leading up to accident, persons involved, response by the Contractor's personnel and result or effect of accident. Obtain and attach witness statements, photographs and sketches as applicable.

1. On the occurrence of an accident or event which causes serious injury to any

person, summon emergency services, notify appropriate authorities and inform the Engineer immediately

1.5 RECORDS & DISTRIBUTION

A. **Wage Books and Time Sheets:** Keep and maintain accurate and proper wage books and time sheets of wages paid to and time worked by all workmen employed by the Contractor and subcontractors at Site. Comply with regulations and requirements, if any, of authorities having jurisdiction. Store wage books and time sheets in field office and make available for the Engineer's inspection and reference during normal working hours. If requested, produce and submit photocopies to the Engineer.

b. **Distribution:** Distribute copies of accepted initial programme to the Employer, separate contractors, and other parties identified by the Contractor with a need-to-know programme responsibility.

1. Post copies in meeting rooms and temporary field offices.

2. Distribute accepted revised programmes to the same parties and post in the same locations. Delete parties from distribution when they have completed their assignments and are no longer involved in performance of construction activities.

SECTION D - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submitting:

1. Shop Drawings.

2. Other miscellaneous submittals.

B. Related Sections include the following:

1. Division 1 Section "Project Management and Coordination" for submitting Coordination Drawings.

2. Division 1 Section "Construction Progress Documentation" for submitting schedules and reports, including the Contractor's Construction Programme, Submittals Schedule and construction photographs.

3. Division 1 Section "Quality Requirements" for submitting test and inspection reports and Delegated-Design Submittals and for erecting mock-ups.

4. Division 1 Section "Closeout Procedures" for submitting warranties project record documents and operation and maintenance manuals.

5. Division 1 Section "Project Record (As-Built) Documents" for submitting record drawings, documents and data.

6. Division 2 Sections for specific submittal requirements.

1.3 SUBMITTAL PROCEDURES

A. **General:** Electronic copies of CAD Drawings of the Contract Drawings will not be provided by the Engineer for the Contractor's use in preparing submittals.

B. **Coordination:** Coordinate preparation and processing of submittals with performance of construction activities.

1. Transmit each submittal sufficiently in advance of performance of related procurement and construction activities, allowing ample time for review and re-submittal if necessary, in order to prevent delays to the Works.

2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

3. Coordinate transmittal of different types of submittals for related parts of the Works so processing will not be delayed because of need to review submittals concurrently for coordination.

a. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. **Submittals Schedule:** Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.

D. **Processing Time:** Allow enough time for submittal review, including time for re-submittals, as follows. Time for review shall commence on the Engineer's receipt of submittal.

1. Initial Review: Allow twenty one (21) days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will advise the Contractor when a submittal being processed must be delayed for coordination.

2. Concurrent Review: Where concurrent review of submittals by sub-consultants, the Employer, or other parties is required, allow thirty five (35) days for initial review of each submittal.

3. If intermediate submittal is necessary, process it in same manner as initial submittal.

4. Allow 21 days for processing each re-submittal.

E. **Identification:** Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.

2. Provide a space approximately 100 x 125 mm on label or beside title block to record the Contractor's review and approval markings and action taken by the Engineer.

3. Include the following information on label for processing and recording action taken:

a. Contract name.

b. The Employer's name.

c. Date.

d. Name and address of the Engineer.

e. Name and address of the Contractor.

f. Name and address of subcontractor.

g. Name and address of supplier.

h. Name and address of manufacturer.

i. Unique identifier, including revision number.

j. Number and title of appropriate Specification Section.

k. Drawing number and detail references, as appropriate.

l. Other necessary identification.

F. **Deviations:** Highlight, encircle, or otherwise indicate and identify on submittals, deviations from the Contract Documents.

G. **Additional Copies:** Unless additional copies are required for final submittal, and unless the Engineer observes non-compliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

1. For submittals requiring concurrent review, submit one extra copy in addition to specified number of copies to the Engineer.

2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.

H. **Transmittal:** Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form attached to a cover letter. The Engineer will discard, without review, submittals received from sources other than the Contractor.

1. Cover Letter: On attached, numbered, separate sheet(s), prepared on the Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by the Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.

a. Include the Contractor's certification stating that information submitted complies with requirements of the Contract Documents.

2. Transmittal Form: Use a form acceptable to and approved by the Engineer. Provide locations on form for the following information:

a. Contract name.

b. The Employer's name.

c. Date.

d. Destination (To:).

e. Source (From:).

f. Names of subcontractor, manufacturer, and supplier, as applicable.

g. Category and type of submittal.

h. Submittal purpose and description.

i. Submittal and transmittal distribution record.

j. Remarks.

k. Signature of transmitter.

I. **Distribution:** Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on

transmittal forms.

J. Use for Construction: Permit only final submittals with appropriate approved stamp, or other mark indicating action taken by the Engineer, to be used in connection with construction.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. **General:** Prepare and submit Action Submittals required by individual Specification Sections.

1. Number of Copies: Submit copies of each submittal, as follows, unless otherwise indicated:

a. Initial Submittal: Submit a preliminary single copy of each submittal where selection of options, colour, pattern, texture, or similar characteristics is required. The Engineer will return submittal with options selected.

b. Final Submittal: Submit four (4) copies, unless otherwise indicated. Submit additional copies where copies are required for operation and maintenance manuals. The Engineer will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Record (As-Built) Document.

B. **Shop Drawings:** Produce newly prepared, Contract-specific, information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Include the following information, as applicable:

a. Dimensions; in SI units unless otherwise indicated or directed.

b. Roughing-in and setting diagrams.

c. Schedules.

d. Compliance with specified standards.

e. Notation of coordination requirements.

f. Notation of dimensions established by field measurement.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least A4 size, and no larger than A1 size, unless otherwise approved.

3. Number of Copies: Submit copies of each submittal, as follows:

a. Initial Submittal: Submit one (1) correctable, translucent, reproducible print and one (1) blue- or black-line print. The Engineer will return the reproducible print.

b. Final Submittal: Submit four (4) blue- or black-line prints, unless otherwise indicated. Submit additional prints where prints are required for operation and maintenance manuals. The Engineer will retain three

(3) prints; remainder will be returned. Mark up and retain one returned print as a Record (As-Built) Drawing.

C. **Coordination Drawings:** Comply with requirements in Division 1 Section "Project Management and Coordination."

D. **The Contractor's Construction Programme:** Comply with requirements in Division 1 Section "Construction Progress Documentation".

E. **Submittals Schedule:**Comply with requirements in Division 1 Section "Construction Progress Documentation."

F. **Subcontract List:** Prepare and submit a list identifying subcontractor individuals or firms proposed for principal portions of the Works, including those who are to fabricate products or equipment to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract.

2. Number and title of related Specification Section(s) covered by subcontract.

3. Drawing number and detail references, as appropriate, covered by subcontract.

2.2 INFORMATIONAL SUBMITTALS

A. **General:** Prepare and submit Informational Submittals required by other Specification Sections.

1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. The Engineer will not return copies.

2. Certificates and Certifications: Provide a notarized statement that includes signature of the Contractor, testing agency, or design professional responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of the company.

3. Test and Inspection Reports: Comply with requirements in Division 1 Section "Quality Requirements."

B. **Qualification Data:** Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and employers, and other information specified.

C. **Material Certificates:** Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

D. **Material Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.

E. **Preconstruction Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.

F. **Compatibility Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

G. **Field Test Reports:** Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.

H. **Product Test Reports:** Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW AND APPROVAL

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to the Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Contract name and location, submittal number, Specification Section title and number, name of reviewer, date of the Contractor's approval, and statement certifying that submittal has been reviewed, checked, coordinated and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

A. **General:** The Engineer will not review submittals that do not bear the Contractor's approval stamp and will return them without action.

B. **The Engineer's Action:** The Engineer's review is limited only to checking conformance with information given and the design concept expressed in the Contract Documents. It is not conducted for the purpose of determining the accuracy and completeness of details, dimensions or quantities, nor substantiating integrity or compatibility, nor confirming instructions for installation or performance. The Engineer's approval does not in any way relieve the Contractor of responsibility for compliance with specified provisions and the Contract Document requirements.

C. **Action Submittals:** The Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it to the Contractor. The Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:

1. Final Unrestricted Release: Where the submittal is marked "APPROVED", the work covered by the submittal may proceed provided it complies with the Contract Documents. Final acceptance of the work will depend on that compliance.

2. Final-but-Restricted Release: Where the submittal is marked "APPROVED AS NOTED", the work covered by the submittal may proceed provided it complies with both the Engineer's notations and corrections on the submittal and the Contract Documents. Final acceptance of the work will depend on that compliance.

3. Returned for Re-submittal: Where the submittal is marked "NOT APPROVED,

REVISE AND RESUBMIT", do not proceed with the work covered by the submittal, including purchase, fabrication, delivery, or other activity for the product submitted. Revise or prepare a new submittal according to the Engineer's notations and corrections.

4. Rejected: Where the submittal is marked "NOT APPROVED, RESUBMIT" or "REJECTED", do not proceed with the work covered by the submittal. Prepare a new submittal for a product that complies with the Contract Documents.

D. **Informational Submittals:** The Engineer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements.

E. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

SECTION E - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.

2. Specified tests, inspections, and related actions do not limit the Contractor's quality control procedures that facilitate compliance with the Contract Document requirements.

3. Requirements for the Contractor to provide quality control services required by the Engineer, the Employer, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:

1. Divisions 2 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. **Quality Assurance Services:** Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.

B. **Quality Control Services:** Tests, inspections, procedures, and related actions performed during and after execution of work, by the Contractor, testing agencies or authorities having jurisdiction, to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by the Engineer.

C. **Testing Agency:** An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.4 SUBMITTALS

A. **Qualification Data:** For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. **Schedule of Tests and Inspections:** Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

C. **Tests and Inspection Reports:** Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

D. **Permits, Licenses, and Certificates:** For the Employer's records, submit copies of permits, licenses, certifications, inspection reports, releases, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the work.

1.5 QUALITY ASSURANCE

A. **Fabricator Qualifications:** A firm experienced in producing products similar to those indicated in the Contract Documents and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. **Factory Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated in the Contract Documents.

C. **Specialists:** Certain sections of the Specifications may require that specific construction activities shall be performed by entities who are recognized experts in

those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

D. **Testing Agency Qualifications:** An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

1.6 QUALITY CONTROL

A. **The Employer Responsibilities:** Where quality-control services are indicated as the Employer's responsibility, the Employer will engage a qualified testing agency to perform these services.

1. The Employer will furnish the Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.

2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to the Contractor.

B. **The Contractor Responsibilities:** Unless otherwise indicated, provide quality control services specified and required by authorities having jurisdiction.

C. **Manufacturer's Field Services:** Where indicated, engage a factory authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.

D. **Retesting/Re-inspecting:** Regardless of whether original tests or inspections were the Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction of revised or replaced work that failed to comply with requirements established by the Contract Documents.

E. **Testing Agency Responsibilities:** Cooperate with the Engineer and the Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify the Engineer and the Contractor promptly of irregularities or deficiencies observed in the work during performance of its services.

2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.

3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through the Contractor.

4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Works.

5. Do not perform any duties of the Contractor.

F. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Site / work.

2. Incidental labour and facilities necessary to facilitate tests and inspections.

3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field-curing of test samples.
5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
6. Security and protection for samples and for testing and inspecting equipment at Project site.

G. **Coordination:** Coordinate sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

H. **Schedule of Tests and Inspections:** Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 28 days of Commencement Date.

1. **Distribution:** Distribute schedule to the Employer, the Engineer, testing agencies, and each party involved in performance of portions of the Works where tests and inspections are required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. **General:** On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.

2. Comply with the Contract Document requirements for Division 1 Section "Cutting and Patching."

B. Protect construction exposed by or for quality control service activities. Repair and protection are the Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

SECTION F - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Related Drawing and Detail.

1.2 PROPRIETARY NAMES

A. In accordance with the PAKISTAN statutory requirements, unless unavoidable, no proprietary products or manufacturers have been named within this Specification.

1.3 SUMMARY

A. This Section includes administrative and procedural requirements relating to products to be used in the Works, including the following:

1. Selection of products for the Works.
2. Quality assurance.
3. Product delivery, storage, and handling.
4. Product warranties.
5. Product substitutions.
6. Comparable products.

B. Related Sections include the following:

Division 1 Section "References Standards industry standards for products specified.and Definitions" for applicable

2. Division 1 Section "Execution Requirements" for general procedural requirements governing execution of the Work.

3. Division 1 Section "Closeout Procedures" for submitting warranties for contract closeout.

4. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.4 DEFINITIONS

A. **Products:** Items purchased for incorporating into the Works, whether purchased for the Works or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

3. Comparable Product: Product that is demonstrated and approved through submittal process, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other

characteristics that equal or exceed the requirements of the Specification.

4. Local Products: Naturally occurring materials found in GCC countries that satisfy the required standards, products manufactured in the PAKISTAN from naturally occurring materials found in GCC countries that satisfy the required standards, or products manufactured in the PAKISTAN that satisfy the required standards.

5. Other Products: All other products required for the Works that satisfy the required standards and which are excluded from the category of "Local Products".

B. **Substitutions:** Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by the Contractor after the date of issue of the Letter of Acceptance. The following are not Substitutions:

1. Revisions to Contract Documents required by the Consultant or Employer.

2. Options for products, materials, equipment and methods of construction, already specified in Contract Documents, including "or approved equal" and “but are not limited to” options.

3. Contractor's compliance with governing regulations or lawful orders issued by authorities having jurisdiction.

C. Manufacturer's Instructions and Manufacturer's Recommendations mean latest published or printed version of 'manufacturer's written instructions' and 'manufacturer's written recommendations.

D. **Manufacturer's Warranty:** Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to the Employer.

E. **Special Warranty:** Written warranty required by or incorporated into the Contract Documents, whether to extend time limit provided by manufacturer's warranty, or to provide for joint and several liability, or to provide more rights for the Employer.

1.5 SUBMITTALS

A. **Product List:** Prepare and submit a list, in tabular form, identifying those products that the Contractor intends to propose for the Works and include the generic names of such products. Include manufacturer's and supplier's name and proprietary product name for each product.

1. Coordinate product list with Contractor's Construction Program, the Submittals Schedule, and the Subcontract List.

2. Initial Submittal: Within 14 days after Commencement Date, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.

a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.

3. Completed List: Within 42 days after Commencement Date, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.

4. Consultant's Action: The Consultant will respond in writing to the Contractor within 28 days of receipt of completed product list. The Consultant's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. The Consultant's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.

B. **Substitution Requests:** Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use a form acceptable to the Consultant.

2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified material or product could not be provided.

b. Coordination information, including a list of changes or modifications needed to other parts of the Works and to construction performed by the Employer and separate contractors, which will be necessary to accommodate proposed substitution.

c. Detailed comparison of significant qualities of proposed substitution with those of the product or work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

e. Samples, where applicable or if requested.

f. List of similar installations for completed projects with project names and addresses and names and addresses of architects/Consultants and owners.

g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

h. Detailed comparison of Contractor's Construction Program using proposed substitution with products specified for the Works, including effect, if any, on the overall Time for Completion. If specified product or method of construction cannot be provided within the Time for Completion, include letter from manufacturer, stating reason for non-availability and/or delays in delivery.

i. Cost information, including a proposal of change, if any, in the Contract Sum.

j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.

3. **Consultant's Action:** If necessary, the Consultant will request additional information or documentation for evaluation within one week of receipt of a request for substitution. The Consultant will notify Contractor of acceptance or rejection of proposed substitution within 28 days of receipt of request, or within 14 days of receipt of additional information or documentation, whichever is later.

a. Form of Acceptance: Variation Order.

b. Use product specified if the Consultant cannot make a decision on use of a proposed substitution within time allocated.

C. **Comparable Product Requests:** Submit three copies of each request for consideration. Identify product or fabrication to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Request Form: Use a form acceptable to the Consultant.

2. Documentation: Show compliance with requirements for approval.

3. Consultant's Action: If necessary, the Consultant will request additional information or documentation for evaluation within one week of receipt of a request. The Consultant will notify the Contractor of acceptance or rejection of proposed comparable product within 28 days of receipt of request, or within 14 days of receipt of additional information or documentation, whichever is later.

a. Form of Acceptance: Variation Order, without additional compensation.

b. Use product specified if the Consultant cannot make a decision on use of a proposed comparable product within time allocated.

1.6 QUALITY ASSURANCE

A. **Alternative Equivalent Standards:** Product references to industry standards establish quantitative and qualitative attributes, characteristics and properties, required to be inherent in the specified product. Standard products not conforming to referenced standards, but otherwise exhibiting the same essential properties and conforming to another recognized equivalent industry standard may be used, subject to approval and compliance with other specified requirements.

1. Comply with provisions in "Comparable Products" Article to obtain approval for use of a product conforming to an alternative equivalent standard.

B. **Compatibility of Options:** If the Contractor is given the option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

2. If a dispute arises between contractors over concurrently selectable but incompatible products, the Consultant will determine which products shall be used.

C. **Source Limitations:** To the fullest extent possible, provide products of the same type and kind from a single source.

1. If a specified product is available only from a source that cannot produce or supply sufficient quantities to execute and/or complete requirements in a timely manner, request the Consultant to determine the most essential qualities, attributes and characteristics required in the specified product, in order to select a comparable product possessing the same relevant, significant properties.

2. Comply with provisions in "Comparable Products" Article to obtain approval.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

1. Schedule delivery to minimize long-term storage at Site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

5. Store products to allow for inspection and measurement of quantity or counting of units.

6. Store materials in a manner that will not endanger the structure of the Permanent Works.

7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

9. Protect stored products from damage.

1.8 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of any obligations under requirements of the Contract Documents.

B. Warranty Requirements:

1. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.

2. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

3. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the

cost of replacing or rebuilding defective work regardless of whether the Employer has benefited from use of the work through a portion of its anticipated useful service life.

4. Employer's Recourse: Expressed warranties made to the Employer are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Employer can enforce such other duties, obligations, rights, or remedies.

C. **Rejection of Warranties:** The Employer reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

D. Where the Contract Documents require a special warranty, or similar commitment on the Works or part of the Works, the Employer reserves the right to refuse to accept the Works, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

E. Manufacturer's and Special Warranties: Prepare a written document, ready for execution, that contains appropriate terms and conditions, and identifies commencement date and warranty period. Submit a draft and obtain the Consultant's written approval before final product selection.

1. Manufacturer's Standard Form: Modified to include requirements and information specific to the Works, and properly executed; or

2. Special Form: Individually prepared and specially drafted to include requirements and information specific to the Works, and properly executed.

3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.

F. Submittal of Warranties: Comply with requirements in Division 1 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 SELECTION OF PRODUCTS WHERE PROPRIETARY NAMES ARE NOT USED

A. All products shall be to a standard not less than the minimum requirements specified.

B. In addition to compliance with the Specification, the Contractor shall submit such further documentation and warranties as the Consultant may request to demonstrate compliance.

C. The products selected and submitted by the Contractor shall fulfill the following criteria:

1. In selecting and submitting products for approval, the Contractor shall only submit products where the stated performance criteria are fully adequate for the operation intended and the Contractor in making the submittal warrants the fitness of purpose of the products.

2. Product manufacturers shall be fully qualified to manufacture the respective products and they shall possess a proven track record of not less than 5 (five) years (preferably 10 years) manufacturing experience in their field. Those with the maximum experience shall be given preference in approval by the

Consultant.

3. "Other Products" shall be either manufactured in, or be a naturally occurring material found in, any of the following geographical locations: Western Europe, North America, Australia or Japan. However, Manufacturers originating from the stated geographical locations who operate in a geographical location other than the stated ones are also acceptable provided that the Contractor can demonstrate that the parent manufacturing company still operates in one of the stated geographical locations.

4. Submittals for "Other Products" assembled in the PAKISTAN must include evidence that demonstrates that the assembly is approved by the original manufacturer.

5. Submittals shall only include products where manufacturers can certify 'forward compatibility' (as applicable) of current models of their products with future models.

6. Submittals shall only include products produced by manufacturers who have received ISO certification for a period of not less than 3 years (preferably 7 years) and preference shall be given by the Consultant to those possessing the longest periods of certification.

7. Submittals shall only include products produced by manufacturers who have had not less than 3 years commercial experience (preferably 7 years) and preference shall be given by the Consultant to those possessing the longest periods.

8. Submittals shall include evidence to demonstrate that the various components of the products are certified by the product manufacturer with respect to specific suitability, country of origin, quality and reliability.

9. Submittals shall include type test certificates (as applicable) issued by an Internationally reputable and accredited testing facility.

10. Submittals for "Other Products" shall include evidence to demonstrate that proposed products have been represented in the PAKISTAN for a period of not less than 3 years (as at date of Tender) and that the PAKISTAN representative maintains a fully equipped and capable technical support facility.

11. Submittals for "Other Products" shall include evidence to demonstrate that the proposed products are supplied through an authorized dealer in the PAKISTAN.

12. Product submittals (as applicable) shall include a re-submittal of the following information as originally submitted by the Contractor for all products included in his Tender lists for "Local Products" and "Other Products":

    a. Guarantee particulars of the Product.

    b. Original catalog of the proposed product manufacturer.

    c. Schedule of users (including names of contact persons) for the previous 5 years.

    d. Schedule of recommended minimum spares based on normal running/usage in the environment proposed projected over a ten year period together with current price lists (major equipment).

    e. Life cycle cost for the product covering the cost of the equipment, spare

parts, maintenance and energy consumption in the environment proposed for the lifetime of the product.

f. Manufacturers' website address.

2.2 PRODUCT OPTIONS

A. **General Product Requirements:** Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. The Employer reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," the Consultant will make selection.

5. Where products are accompanied by the term "match sample," sample to be matched is the Consultant's.

6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.

7. Or Approved Equal: Where products are specified by name and accompanied by such terms as "or other equal and approved", "or approved equal" "or equal", or “but are not limited to” comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

   a. The Consultant reserves the right to limit selection to named products specified.

   b. Unless otherwise agreed, contract unit rates and prices will be deemed to be based on the use of named products specified in the Contract Documents.

B. **Product Selection Procedures:** Procedures for product selection include the following:

1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named, unless otherwise indicated.

2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements, unless otherwise indicated.

3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements, unless otherwise indicated.

4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements, unless otherwise indicated.
5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of a product by another manufacturer.
7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Product" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches the Consultant's sample. The Consultant's decision will be final on whether a proposed product matches satisfactorily.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
    a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, the Consultant will select color, pattern, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, the Consultant will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.3 PRODUCT SUBSTITUTIONS

A. **Timing:** The Consultant will consider requests for substitution if received within 60 days after date of Letter of Acceptance. Requests received after that time may be considered or rejected at discretion of the Consultant.

B. **Conditions:** The Consultant will consider the Contractor's request for substitution

when the following conditions are satisfied. If the following conditions are not satisfied, the Consultant will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers the Employer a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities the Employer must assume. The Employer's additional responsibilities may include compensation to the Consultant for redesign and evaluation services, increased cost of other construction by the Employer, and similar considerations.
2. Requested substitution does not require extensive revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect the Contractor's Construction Program.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Works.
8. Requested substitution has been coordinated with other portions of the Works.
9. Requested substitution provides specified warranty.
10. If requested substitution involves other contractors, requested substitution has been coordinated with the work of such other contractors, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2.4 COMPARABLE PRODUCTS

A. Where products are specified by name or industry standard, submit the following, in addition to other required submittals, to obtain approval of an unnamed or alternative equivalent industry standard, product:

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Works.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty, if any.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects/Consultants and employers, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

SECTION G - EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes general procedural requirements governing execution of the Works including, but not limited to, the following:

1. Construction layout.
2. Field Consultations and surveying.
3. General installation of products.
4. Coordination of the Employer-installed products.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of work.

B. Related Sections include the following:

1. Division 1 Section "Project Management and Coordination" for procedures for coordinating field Consultanting with other construction activities.
2. Division 1 Section "Submittal Procedures" for submitting surveys.
3. Division 1 Section "Closeout Procedures" for final cleaning.

1.3 SUBMITTALS

A. Method Statement: Submit method statement to be used for construction layout.

B. Landfill Receipts: If Contract Documents contain requirement for hazardous waste disposal, submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. **Existing Conditions:** The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Works.

1. Before construction, verify the location and points of connection of utility services.

B. **Existing Utilities:** The existence and location of underground and other utilities and

construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Works.

C. **Acceptance of Conditions:** Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Written Report: Where a written report listing conditions detrimental to performance of the work is required by other Sections, include the following:

   a. Description of the work.

   b. List of detrimental conditions, including substrates.

   c. Recommended corrections.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

3.2 PREPARATION

A. **Existing Utility Information:** Furnish information to the Consultant that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate, where necessary, with authorities having jurisdiction.

1. Notify the Consultant and the Employer not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without the Consultant's written permission.

B. **Field Measurements:** Take field measurements as required to fit the construction properly. Recheck measurements before installing each product. Where portions of the Works are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Works.

C. **Space Requirements:** Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. **Review of Contract Documents and Field Conditions:** Immediately on discovery of any discrepancy or the need for a clarification of the Contract Documents, submit a request for information or instruction to the Consultant. Include a detailed description of discrepancy or problem encountered, together with recommendations.

3.3 CONSTRUCTION LAYOUT

A. **Method Statement:** Before verifying layout information shown on Drawings, prepare a detailed method statement comprising a descriptive narrative and drawings, clearly describing and identifying means and methods to be used for construction layout including but not limited to:

1. Establishing benchmarks and control points to set lines and levels at each storey of construction and elsewhere as needed to locate each element of the Works.

2. Locating offsets for gridlines.

3. Locating and sizing penetrations in structures as needed to transfer lines and levels horizontally and vertically.

B. **Verification:** Before proceeding to set out the Works, verify layout information shown on Drawings, in relation to the Contractor's site survey and existing benchmarks. If discrepancies are discovered, notify the Consultant promptly.

C. **General:** Set out the Works using accepted surveying techniques and practices.

1. Establish benchmarks and control points to set lines and levels at each storey of construction and elsewhere as needed to locate each element of the Works.

2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.

3. Inform installers of lines and levels to which they must comply.

4. Check the location, level and plumb, of every major element as work progresses.

5. Notify the Consultant when deviations from required lines and levels exceed allowable tolerances.

6. Close site surveys with an error of closure equal to or less than the standard indicated or otherwise as acceptable to the Consultant.

D. **Record Log:** Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by the Consultant.

1. Advise the Consultant when deviations, exceeding indicated or recognized tolerances, are detected.

2. Record deviations that are accepted and not corrected on Record (As-Built) Drawings.

E. **Auxiliary Services:** Cooperate with the Consultant and provide, when requested, auxiliary services to enable and assist the Consultant to check the Contractor's site survey, layout and control work, including means of access to Site, use of instruments and tapes, and supply of survey crew.

3.4 FIELD CONSULTANTING

A. **Identification:** The Consultant will identify existing benchmarks and control points.

B. **Reference Points:** Locate existing permanent benchmarks, control points, and similar reference points before beginning the Works. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of the Consultant. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to the Consultant before proceeding.

2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. **Benchmarks:** Establish and maintain a minimum of two permanent benchmarks on Site, referenced to data established by survey control points. Comply with the Consultant's instructions for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Record (As-Built) Drawings.

2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Works.

3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

D. **Record Log:** Maintain a log of field Consultanting work. Include dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by the Consultant.

3.6 PROGRESS CLEANING

A. **General:** Clean Site and work areas daily, including common areas. Coordinate and contribute to progress cleaning for Site and work areas jointly-used with other separate contractors. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 27 deg C.

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. **Site:** Maintain Site free of waste materials and debris.

C. **Work Areas:** Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Works.

E. **Concealed Spaces:** Remove debris from concealed spaces before enclosing the space.

F. **Exposed Surfaces:** Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. **Cutting and Patching:** Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

H. **Waste Disposal:** Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

E. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

F. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

G. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 CORRECTION OF WORK

A. **Repair or remove and replace defective construction.** Restore damaged substrates and finishes. Comply with requirements in Division 1 Section "Cutting and Patching."

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their original condition, unless otherwise specified.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

SECTION H - RECORD (AS-BUILT) DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and other Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Record (As-Built) Documents, including the following:

1. Record Drawings.

2. Record Specifications.

3. Miscellaneous Records.

B. Related Sections include the following:

1. Division 1 Section "Summary of Multiple Contracts" for coordinating Project Record Documents covering the Work of multiple contracts.

2. Division 1 Section "Closeout Procedures" for general closeout procedures.

3. Divisions 2 Sections for specific requirements for Record (As-Built) Documents in those Sections.

4. Divisions 2 Sections for specific requirements for Miscellaneous Record keeping and submittal in those Sections.

1.3 SUBMITTALS

A. **Record Drawings:** Submit copies of Record Drawings as follows:

1. Initial Submittal: Submit two sets of plots from Record CAD Drawing files and the original marked-up Record Prints. The Consultant will initial and date one set of plots and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. The Consultant will return one set of plots and Record Prints together with review comments, for completing, printing, binding, and final submittal.

2. Final Submittal: After incorporating the Consultant's initial submittal review comments, submit:

   a. Original marked-up Record Prints set.

   b. Sets of (As-Built) Drawings as follows:

      1) One (1) Set electronic format: (in CD-ROM)

      2) One (1) set of Mylar reproducible polyester film (Mylar)

      3) Two (2) bound sets of prints (A2 Size)

4) One (1) set of loose copy (blue print/black line print). Size should be the same as the original Mylar/Polyester films

5) One (1) set of any other document/report about the project, Test results and any other information/documents..

B. **Record Specifications:** Submit two (2) copies of Record Specifications, including addenda and contract modifications.

C. Miscellaneous Records: Submit two (2) sets of original miscellaneous records.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. **Record Prints:** During construction period, print and maintain one set of blue- or black-line white prints of all Contract Drawings, approved Shop Drawings and newly prepared Drawings, for Record Print purposes.

1. Preparation: Mark Record Prints to indicate all changes and field adjustments and to show the actual installation where installation varies from that shown originally.

   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

   b. Accurately record information in an understandable drawing technique.

   c. Record data as soon as possible after obtaining it. Record and check the mark-up before enclosing concealed installations.

2. Content: Types of items requiring marking include, but are not limited to, the following:

   a. Dimensional changes to Drawings.

   b. Revisions to details shown on Drawings.

   c. Locations and depths of underground utilities.

   d. Revisions to routing of piping and conduits.

   e. Revisions to electrical circuitry.

   f. Changes made by Variation or Site Instruction directives.

   g. Changes made following the Consultant's written orders and the Consultant's acceptance of substitutions or alternatives, etc.

   h. Details not on the original Contract Drawings.

   i. Field records for variable and concealed conditions.

   j. All coordinates shown on the drawings should be in DLTM.

3. Mark record prints of Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.

4. Mark record prints with erasable, red-coloured pencil. Use other colours to distinguish between changes for different categories of work at the same location.

5. Mark important additional information that is either shown only schematically or omitted from original Drawings.

6. Note Variation numbers, Site Instruction numbers, and similar identification, where applicable.

B. **Newly Prepared Record Drawings:** Prepare new Drawings where the Consultant determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.

1. New Drawings may be required when a Variation is issued or as a result of the Consultant accepting an alternate, substitution, or other modification.

2. Consult with the Consultant for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

C. **Progress Review:** Unless otherwise indicated or directed, submit a copy of marked-up Record Prints and newly prepared Record Drawings at monthly intervals, for progress review and acceptance by the Consultant.

1. Limit submittals to drawings marked-up, prepared or further amended since previous submittal. List drawings contained in each submittal on transmittal form.

D. **Record CAD Drawings:** Before requesting inspection for determining date of Substantial Completion, review marked-up final Record Prints with the Consultant. When authorized, prepare a full set of CAD Drawings of all Contract Drawings, Shop Drawings and newly prepared Drawings, whether or not changes or additional information are recorded:

1. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.

2. Refer instances of uncertainty to the Consultant for resolution.

3. Identify and date each Record Drawing; include the designation "RECORD (AS-BUILT) DRAWING" in a prominent location.

E. **Record CAD Drawing Plots:** Produce a full set of Record Drawing Plots from completed Record CAD Drawing files.

F. Final Submittal Format:

1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with thick cover sheets. Include identification and list contents on cover sheets.

2. Record CAD Drawings: Organize CAD information into separate electronic files that correspond to each sheet of the Record Prints. Produce "List of Drawings" sheet. Name each file with the sheet identification number. Include identification in each CAD file. All as follows:

a. All As-Built drawings and GIS files to be submitted in DLTM coordinate

system, which is UAE Standard coordinate system.

b. The master map unit for As-Built drawings and GIS files should be in meter (m) only. (For Microstation drawings, sub unit should be 1000 (mm) and positional unit should be 80).

c. All As-Built CAD drawings and GIS files to be submitted in digital formats on CD's media.

d. As-Built CAD and GIS formats are both required for any As-Built design / entity submission.

e. All As-Built GIS maps to be submitted in standard shape files.

f. All As-Built CAD drawings should be submitted in original Microstation format, (not converted), unless special permission is obtained from DCA for other format.

g. In the event of such special permission being granted, for AutoCAD drawings, pen width details for plotting should also be provided in each drawing. (Outside the drawing area).

h. In Microstation files for 2D drawings always use 2D seed files.

i. All reference files (if used) should be copied in a directory called 'reference'.

j. If any of the files/drawings are using fonts other than the normal fonts provided by the software, that fonts also should be copied in a separate directory called 'fonts'.

k. Drawing should be neat and perfect. None of the items should be outside the drawing sheet area.

l. Drawings of different disciplines (i.e. Architectural, Structural, Electrical, Mechanical etc.) should be kept in separate directories with suitable names.

m. One file shall contain only one drawing.

n. Drawing should be drawn/organized in suitable/proper layers/levels. Same kind of items should always be in the same layer/level.

o. Drawing should be copied into CD' in such a way that, when one drawing from the CD is opened, it must be complete and all reference files, fonts and libraries (if used) should attach automatically.

p. The index of drawings should also be provided in the original format of the drawing (DGN or DWG) and it must be kept in a directory called "general".

q. Total number of As-Built drawings in the index and in the CD should be the same.

r. Change notice drawings should submit along with all other drawings of that TD in a new CD.

3. Polyester Copy (Mylars): Organize into unbound sets matching Record Prints. Place in durable tube-type drawing containers with end caps. Mark end cap of each container with identification. If container does not include a complete set of Drawings, attach label and identify Drawings included. All as follows:

a. All the drawings must be either A0 or A1 size. (Standard).

b. Maximum size of the sheet should not exceed 1200 x 880 mm.

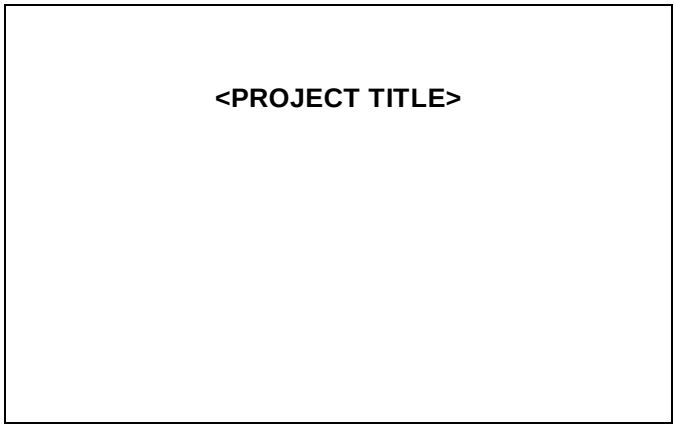
c. All drawings must be in good quality polyester films and not in tracing paper.

4. Copy Prints: Organize into bound sets matching Record CAD Drawing Plots. The Consultant will deliver the Employer copy sets. All as follows:

   a. They must be in standard in A2 size.

   b. They must be properly bound using thick covering sheets.

   c. Laminated labelling must be as in the following format:



   d. The scale of the drawings in the bound book should match with the scale shown in the title block of the drawing of bound book.

5. General (for Soft copy & Hard copy)

   a. Each document should be verified thoroughly by the consultant/contractor before submission.

   b. "As-Built" stamp/seal with date and signature of the verified person should be provided in each drawing.

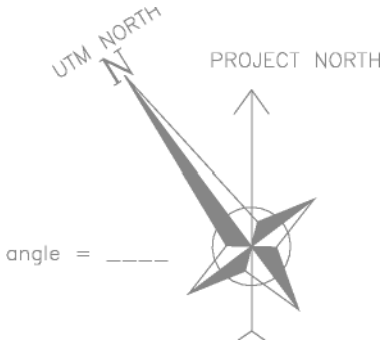
   c. "As-Built" stamp/seal (item 5. b above) should be exactly like below:

   d. Drawing should be in proper scale and Contract number, its description & scale of the drawing should also be mentioned in the title block along with other details.

Discipline (Architectural, Structural, Mechanical, etc.)					
Sl. No.	Sheet no.	Drg. No.	Rev no.	Drg. File name	Description

   e. Key plan & north symbol should be provided in the upper right corner of the drawings (wherever it is applicable).

f. North symbol (item 5. e above) should be like as below sample:



g. Provide hard copy of list (index) of drawings as in the following format:

h. All the drawings must be numbered serially (sheet number), starting from 001 (drawing index as sheet no. 001) and it must be showed in the drawing index. (Total number of drawings in one Contract should be same as the sheet number of the last drawing).

i. One file should contain only one drawing. (This point is also incorporated under item 2.1. F.2 above).

j. All As-Built drawings and GIS files to be submitted in DLTM coordinate system which is UAE Standard coordinate system.

k. All As-Built CAD drawings and GIS files to be submitted in digital formats on CD's media.

l. As-Built CAD and GIS formats are both required for any As-Built design / entity submission.

m. All As-Built GIS maps to be submitted in standard shape files.

n. All naming, numbering and related attribute information for As-Built to be matched with DCA standards.

2.2 RECORD SPECIFICATIONS

A. **Record Specifications:** During construction period, print and maintain two copies of the Specifications, including addenda and contract modifications issued, for Record Specification purposes.

B. **Preparation:** Mark Record Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.

3. Record the name of the manufacturer, supplier, Installer, and other

information necessary to provide a record of selections made.

4. Note related Variation numbers and Record Drawings where applicable.

2.3 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference. Miscellaneous records include, but are not limited to, the following:

1. Field records on excavations and fillings.

2. Surveys showing locations and elevations of underground lines.

3. Special and authorized measurements.

4. Tests and inspections.

5. Inspections and certifications by governing authorities.

6. Final inspection and correction procedures.

7. Any other information / documents which are not included on As-Built Drawings and Operation and Maintenance Manuals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. **Recording:** Mark up Record Documents as the Work is progressively accomplished and completed relative to each Record Document. Record changes and modifications as they occur; do not wait until the end of Project.

B. **Maintenance of Record Documents:** Store Record Documents in field office, apart from the Contract Documents used for construction. Do not use Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Make Record Documents available for the Consultant's inspection and reference during normal working hours.

SECTION 1 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Conditions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes construction dewatering.

B. Related Sections include the following:

1. Division 1 Section "Temporary Facilities"
2. Division 2 Section "Site Clearing."
4. Division 2 Section "Earthwork" for excavating, backfilling, and site grading.

1.3 PERFORMANCE REQUIREMENTS

A. **Dewatering Performance:** Design, provide, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1. Work includes removing dewatering system when no longer needed.
2. Maintain dewatering operations to ensure erosion is controlled, stability of excavations and constructed slopes is maintained, and flooding of excavation and damage to structures are prevented.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Undertake all necessary temporary works to accomplish dewatering without damaging existing buildings, structures, utilities and site improvements adjacent to excavation.

1.4 SUBMITTALS

A. **Shop Drawings:** For dewatering system. Show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written report outlining control procedures to be adopted if dewatering problems arise.
3. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified.

C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

D. **Field Test Reports:** Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting

performance requirements.

E. **Field Records:** Survey logs and Observation well reports.

1.5 QUALITY ASSURANCE

A. **Installer Qualifications:** Engage an experienced installer to assume engineering responsibility and perform dewatering who has specialized in installing dewatering systems similar to those required for this Project and with a record of successful in-service performance.

B. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services for designing dewatering systems that are similar to those indicated for this Project in material, design, and extent.

1. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for the dewatering system including drawings, testing program, test result interpretation, and comprehensive engineering analysis that shows the system's compliance with specified requirements.

C. **Regulatory Requirements:**Comply with water disposal requirements of authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. **Existing Utilities:** Do not interrupt or interfere with utilities serving facilities on the Project site or on adjoining property unless permitted in writing by the Engineer and then only after arranging to provide temporary utility services according to requirements indicated or directed.

B. **Project Site Information:** A geotechnical assessment has been prepared for this Project and has been made available for information only. The Contractor is entirely responsible for his own assessment, interpretation, use and conclusions drawn from the information, data, tests, analyses and opinions contained in the assessment.

1. Make additional test borings and conduct other exploratory operations as deemed necessary, at own cost and expense.

C. Survey adjacent structures and site improvements, employing a qualified professional engineer or surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. Weekly during dewatering, and at completion, resurvey benchmarks, maintaining an 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 in adjacent construction.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements and other facilities, on or adjacent to the site, from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

B. Install dewatering system to ensure minimum interference with adjoining roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Engineer and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by the Engineer or authorities having jurisdiction.

3.2 DEWATERING

A. Provide, design, install, and operate a dewatering system that will minimize conditions or softening of foundation strata; and maintain stability of the sides and bottom of excavation, all resulting in every phase of excavation, construction, and backfilling operations being performed in the dry.

B. Reduce hydrostatic head in the water-bearing strata to below structure foundations, drains, sewers and other excavations to extent that ground water levels in construction areas are below the maximum excavation depth by a minimum of 1 m.

C. Prior to excavation below groundwater level, place dewatering system into operation to lower and maintain the specified water levels for a 24-hour period and then operate it continuously 24 hours a day, 7 days a week until drains, sewers and structures have been constructed, including placement of fill materials, and until written authorization to cease dewatering is received from the Engineer.

D. Control of all surface and subsurface water resulting from operations. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner to avoid inconvenience to others in a manner approved by the Engineer.

E. Provide standby equipment on the Project site, installed and available, for immediate operation if required to maintain dewatering on a continuous basis in the event that any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional expense.

F. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

G. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner to avoid inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices acceptable to the Engineer and as required by authorities having jurisdiction.

H. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or other acceptable material, or cut off and cap wells a minimum of 900 mm below overlying construction.

I. Damages: Promptly repair and restore to original condition, any damages to adjacent structures, utilities, sidewalks, pavements and other facilities on or adjacent to the site, caused by dewatering operations, to the satisfaction of the Engineer.

3.3 OBSERVATION WELLS

A. Provide, take measurements, and maintain as a minimum at least four observation wells or piezometers in locations indicated or directed, together with any additional observation wells as may be required by the Engineer or authorities having jurisdiction.

B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells

are functioning properly.

1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

3.4 INSPECTION

A. Inspect the dewatering system at least once each day during periods when the workforce is not on the Project site.

SECTION 2 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of the Contract, including Conditions of Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing and grading sub-grades for slabs-on-grade and pavements.
2. Preparing sub-grades for roadways and vehicular pavements.
3. Excavating and backfilling for buildings and structures.
4. Excavating and backfilling for roadways and vehicular pavements.
5. Drainage and moisture-control fill course for slabs-on-grade.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches and pits within building lines.
8. Excavating and backfilling trenches and pits for buried mechanical and electrical utilities and appurtenances.
9. Excavation support and protection not otherwise provided for in other Sections of the Specification.

B. Related Sections include the following:

1. Division 2 Section "Dewatering" for lowering and disposing of ground water during construction.
2. Division 2 Section "Aggregate Sub-base" for sub-base to roadways and vehicular pavements.
3. Division 2 Section "Aggregate Base Course" for base course to roadways and vehicular pavements.
4. Division 2 Section “Bituminous Concrete Pavement" for areas to be paved with asphalt.

1.3 DEFINITIONS

A. **Excavation:** consists of the removal of material encountered to sub-grade elevations and the reuse or disposal of materials removed.

B. **Backfill:** Soil materials used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

C. **Borrow:** Soil material obtained off-site when sufficient approved soil material is not available from excavations.

D. **Drainage Blanket:** Course of washed granular material placed to cut off upward capillary flow of pore water.

E. **Unauthorized Excavation:** Unauthorized excavation consists of removing materials beyond indicated sub grade elevations or dimensions without direction by the Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, will be at the Contractor's expense.

F. **Structures:** Buildings, footings, foundations, retaining walls, slabs, tanks, curbs,

mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

G. **Utilities:** Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

H. **Bedding Course:** Layer placed over the excavated sub-grade in a trench before laying pipe.

I. **Capillary Water Barrier:** Layer supporting slab-on-grade used to minimize capillary flow of pore water.

J. **Fill:** Soil materials used to raise existing grades generally.

K. **Sub-grade:** Surface or elevation remaining after completing excavation, or top surface of a fill or backfill or sub grade layer, immediately below sub base, drainage fill, slab-on-grade, or topsoil materials.

1.4 SUBMITTALS

A. **Pre-construction Records:** Before an excavation is started:

1. Ground levels shall be agreed at suitable intervals with the Engineer.
2. Surface materials and conditions shall be recorded in presence of the Engineer and where appropriate, the Employer or occupiers of the land.
3. The Contractor shall take photographs to illustrate existing damage or conditions, which may prove contentious at the time of reinstatement.
4. This information shall be neatly presented and submitted to the Engineer.

B. Any significant details of any existing natural or piped subsoil drainage or other underground features shall be identified to the Engineer as work proceeds.

C. For excavations for pipelines or lengthy conduit installations, trial excavations shall be carried out along the route of pipeline/underground conduit for location of all existing services and findings shall be presented on drawings with location, type and levels. All services shall be included in final drawings. The excavations shall not be backfilled without approval.

D. **Temporary Support System:** Design of temporary support system, where required.

E. **Product Data:** For the following:

1. Each type of plastic warning tape.
2. Drainage fabric.
3. Separation fabric.

F. **Samples:** For the following:

1. 50 kg samples sealed in airtight containers, of each proposed soil material from on-site or borrow sources.
2. 300 mm x 300 mm sample of drainage fabric.
3. 300 mm x 300 mm sample of separation fabric.

G. **Material Test Reports:** From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for backfill, fill, embankment and sub grade layer.
2. Laboratory compaction curve according to ASTM D 1557 (Modified Proctor) for each on-site or borrow soil material proposed for backfill, fill, embankment and sub grade layer.

1.5 QUALITY ASSURANCE

A. **Geotechnical Testing Agency Qualifications:** An independent testing agency acceptable to the Engineer and qualified according to ASTM E 329 to conduct soil materials testing, as documented according to ASTM D 3740 and ASTM E 548.

B. **Pre-excavation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Coordination."

1.6 PROJECT CONDITIONS

A. **Existing Utilities:** Survey to determine locations, sizes, and types of such utilities within construction areas in advance of disturbing them. Provide proper safeguard, support and protection from construction activities. Do not interrupt existing utilities serving facilities occupied by the Employer or others except when permitted in writing by the Engineer and then only after acceptable temporary utility services have been provided.

1. Provide a minimum 48-hours' notice to the Engineer and receive written notice to proceed before interrupting any utility.

B. **Traffic Control:** Maintain access for vehicular and pedestrian traffic as required for other construction activities in the area and as discussed/directed by the Engineer.

C. Demolish and completely remove from site existing underground piping, conduit, manholes, and other utilities within the limits of excavations, which are indicated to be abandoned, and plug open ends with concrete.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. **General:** Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. **Satisfactory Soils:** ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 75 mm in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. **Unsatisfactory Soils:** ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. **Backfill and Fill:** Satisfactory soil materials.

E. **Sub grade Layer:** Satisfactory roadway soil materials, but conforming with the following requirements:

1. Size: 100 percent passing a 75 mm sieve and not more than 18 percent passing a 0.075 mm sieve.
2. Organic Matter: Not more than 5 percent; AASHTO T 267.
3. Maximum Dry Density: Not less than 1.7; AASHTO T 180.
4. CBR: Not less than 15 percent; AASHTO T 193.
5. Maximum Plasticity Index: 12 percent.
6. The top 150 mm sub grade material should not contain more than 0.2% total sulphate content and 0.05% total chloride content.

F. **Controlled Fill:** Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; AASHTO M 57; with at least 90 percent passing a 38 mm sieve and not more than 12 percent passing a 0.075 mm sieve.

G. **Bedding:** Naturally or artificially graded mixture of natural or crushed gravel,

crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 25 mm sieve and not more than 8 percent passing a 0.075 mm sieve.

H. **Drainage Fill:** Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 38 mm sieve and 0 to 5 percent passing a 2.36 mm sieve.

I. **Filter Material:** Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 25 mm sieve and 0 to 5 percent passing a 4.75 mm sieve.

2.2 ACCESSORIES

A. **Warning Tape:** Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities and as per DEWA standard, 150 mm wide and 0.1 mm thick, continuously inscribed with a description of the utility; colored as follows:

B. **Detectable Warning Tape:** Acid and alkali resistant polyethylene film warning tape manufactured for marking and identifying underground utilities and as per local authority guidelines, minimum 150 mm wide and 0.1 mm 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 750 mm deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

C. **Drainage Geocomposite:** composed of a drainage geonet core with non-woven geotextile bonded to both sides of the geonet core. The geotextile shall only be heat bonded to the geonet core; no other means of bonding shall be used. The polymer used to manufacture the geonet core shall be high density polyethylene. Manufacturer shall certify that the geonet is manufactured from first quality virgin polymer and no regrind material is used in the geonet manufacturing process. The non-woven geotextile shall be made from needle punched or heat-bonded polypropylene or polyester staple or continuous fiber. Alternative to these materials and manufacturing processes may be approved by the Engineer. Conformance to the following properties shall be according to ASTM D 4759 and referenced standard test methods:

Geonet

Thickness (Min): 0.635 cm; ASTM D 5199

Tensile Strength (Min): 5.8 kN/m; ASTM D 4595

Density (Min): 0.94 g/cm^3, ASTM D 1505

Melt Flow Index (Max): D 1238 g/10 min 1.0; ASTM D 1238

Carbon Black Content (range): 2 -3 %; ASTM D 1603

Geotextile

1. Grab Tensile Strength (Min): 712 N; ASTM D 4632.
2. Tear Strength (Min): 266 N; ASTM D 4533.
3. Puncture Resistance (Min): 266 N; ASTM D 4833.
4. Apparent Opening Size (Max): 0.21 mm; ASTM D 4751.

Geocomposite

Ply Adhesion (Min): 90 g/cm; ASTM D7005

Transmissivity (Min): 1.0E-03 m^2/sec; ASTM D4716. Transmissivity is measured after 100 hours seating period with boundary conditions: Ottawa Sand/ GDL/ Geomembrane/ Steel Plate at a hydraulic gradient of 0.33 and normal stress of 50 kPa.

D. Separation Fabric Nonwoven geotextile made from needle punched or heat-bonded polypropylene or polyester staple or continuous fiber. Alternative to these materials and manufacturing processes may be approved by the Engineer. Conformance to the following properties shall be according to ASTM D 4759 and referenced standard test methods:

1. Grab Tensile Strength (Min): 890 N; ASTM D 4632.
2. Tear Strength (Min): 355 N; ASTM D 4533.
3. Puncture Resistance (Min): 355 N; ASTM D 4833.
4. Apparent Opening Size (Max): 0.18 mm; ASTM D 4751.

2.3 EXCAVATION SUPPORT AND PROTECTION SYSTEMS

A. Materials need not be new, but must be suitable and fit for purpose, in serviceable condition and acceptable to the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shore, support and protect buildings, structures, utilities, sidewalks, pavements, and other facilities, on or adjacent to the Project site, from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect sub grades and foundation soils. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared sub grades, and from flooding Project site and surrounding area.

B. Protect sub grades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep sub grades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXCAVATION SUPPORT AND PROTECTION

A. Design, provide, install, monitor, and maintain at the Contractor's sole risk and responsibility, excavation support and protection systems capable of resisting soil and hydrostatic pressure and supporting sidewalls of excavations.

1. Work includes removing when no longer needed.
2. Install and remove without damaging existing structures, utilities, pavements, and other facilities adjacent to excavations.

B. Install excavation support and protection systems as excavation works proceed, in a manner acceptable to the Engineer.

1. Locate clear of permanent construction to permit access for subsequent construction operations and inspections.

2. Trim excavation as required and fill voids behind with soil, and compact.

C. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure excavation support and protection remains stable.

D. Remove excavation support and protection systems when construction has progressed sufficiently. Remove in stages to avoid disturbing underlying soils and damaging adjacent structures, utilities, pavements and other facilities.

Promptly repair or replace as directed and approved by the Engineer, adjacent work, structures, utilities, pavements and other facilities, damaged or displaced by installing or removing excavation support and protection systems.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation to sub grade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, boulders, and obstructions.

1. If excavated materials intended for backfill, fill, embankment, or sub grade layer include unsatisfactory soil materials and rock, replace with satisfactory soil materials, as applicable.

2. Excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other encountered items indicated or directed to be removed; together with other materials not classified as unauthorized excavation; including intermittent drilling, blasting if permitted, ram hammering, ripping and other acceptable means and methods.

3. Excavation includes removal and disposal of unsatisfactory soils and any surplus satisfactory soils.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm. Extend excavations a sufficient distance from permanent structures for working space requirements. Place blinding concrete, where indicated, immediately after excavating to final grades.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement or concrete. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 25 mm. Do not disturb bottom of excavations intended for bearing surface.

3.6 EXCAVATION FOR PAVEMENTS AND SITE IMPROVEMENTS

A. Excavate surfaces under roadways, parking lots, walks, pedestrian pavements, lawns, planted areas and the like, to indicated cross sections, elevations, and grades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Set out trenches so that they do not encroach below a line drawn at an angle,

from the horizontal of the nearest lower edge of any adjacent building foundation, as follows:

a. In Dry Stable Soils: 45 degrees.

b. In Wet Clays, or Soils below Water Table: 30 degrees.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 300 mm higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: 300 mm on each side of pipe or conduit, unless otherwise indicated.

C. **Trench Bottoms:** Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape sub grade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench sub grade.

1. For pipes and conduit less than 150 mm in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed sub grade.

2. For pipes and conduit 150 mm or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

3. Excavate trenches 150 mm deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. **Trench Bottoms:** Excavate trenches 100 mm deeper than bottom of pipe elevation to allow for bedding course. Remove projecting stones and sharp objects along trench sub grade. Hand excavate for bell of pipe.

1. Excavate trenches 150 mm deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 APPROVAL OF SUBGRADE

A. Notify the Engineer when excavations have reached required sub-grade.

B. If the Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill, fill or sub-grade layer material as applicable, and as directed.

1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

C. Proof rolls expansive sub-grade areas with heavy pneumatic tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated sub-grades.

D. Reconstruct sub-grades damaged by rain, accumulated water, or construction activities, as directed by the Engineer.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by the Engineer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by the Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrows materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.

3.12 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Backfill trenches excavated under footings and within 450 mm of bottom of footings; fill with concrete to elevation of bottom of footings.

C. Provide 100 mm thick, concrete-base slab support for piping or conduit less than 750 mm below surface of roadways and vehicular pavements. After installing and testing, completely encase piping or conduit in a minimum of 100 mm of concrete before backfilling.

D. Place and compact initial backfill of satisfactory soil material, free of particles larger than 25 mm, to a height of 300 mm over the utility pipe or conduit.

1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

E. Coordinate backfilling with utilities testing.

F. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

G. Place and compact final backfill of satisfactory soil material to final sub grade.

H. Install warning tape directly above utilities, 300 mm below finished grade, except 150 mm below sub grade under pavements and slabs.

3.13 FILL AND EMBANKMENT

A. **Preparation:** Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fill and embankment material.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill and embankment material will bond with existing material.

C. Place and compact fill and embankment material in layers to required elevations as follows:

1. Under footings and foundations, use controlled fill.
2. Under building slabs, ramps and steps, use controlled fill.
3. Under roadways and vehicular pavements, use embankment material.
4. Under walks and pedestrian pavements, use satisfactory soil material.
5. Under lawns and planted areas, use satisfactory soil material.

3.14 MOISTURE CONTROL

A. Uniformly moisten or aerate sub grade and each subsequent backfill, fill or embankment layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill, fill or embankment material on surfaces that are muddy.
2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry density.

3.15 COMPACTION OF BACKFILLS, FILLS AND EMBANKMENT

A. Place soil materials in layers not more than 200 mm in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm in loose depth for material compacted by hand-operated tampers.

B. Place soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact backfills and fills to not less than the following percentages of maximum dry density according to ASTM D 1557:

D. Compact backfills and fills to not less than the following percentages of maximum dry density according to ASTM D 698:

1. Under structures, building slabs, ramps and steps, scarify and recompact top 300 mm of existing sub grade and each layer of backfill or fill material at 100 per cent.
2. Under walks and pedestrian pavements, scarify and recompact top 150 mm below sub grade and compact each layer of backfill or fill material at 100 per cent.
3. Under lawns or unpaved areas, scarify and recompact top 150 mm below sub grade and compact each layer of backfill or fill material at 85 per cent.

3.16 GRADING

A. **General:** Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. **Site Grading:** Slope grades to direct water away from buildings and to prevent ponding. Finish sub grades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 25 mm.
2. Walks and Pedestrian Pavements: Plus or minus 25 mm.
3. Roadways and Vehicular Pavements: Plus or minus 25 mm.

C. **Grading inside Building Lines:** Finish sub grade to a tolerance of 13 mm when tested with a 3 m straightedge.

3.17 SUBSURFACE DRAINAGE

B. **Subsurface Drain:** Place a layer of drainage fabric around perimeter of drainage trench as indicated. Place a 150 mm course of filter material on drainage fabric to support drainage pipe. Encase drainage pipe in a minimum of 300 mm of filter material and wrap in drainage fabric, overlapping sides and ends at least 150 mm.

1. Compact each course of filter material to 95 percent of maximum dry density according to ASTM ASTM D 1557.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 300 mm of final sub grade. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 150 mm.

1. Compact each course of filter material to 95 percent of maximum dry density according to ASTM D 1557.

2. Place and compact impervious fill material over drainage backfill to final sub grade.

3.18. DRAINAGE COURSE

A. Under slabs-on-grade, install drainage fabric on prepared sub grade according to manufacturer's written instructions, overlapping sides and ends. Place drainage course on drainage fabric and as follows:

B. Under slabs-on-grade, place drainage course on prepared sub grade and as follows:

1. Compact drainage course to required cross sections and thickness to not less than 95 percent of maximum dry density according to ASTM D 1557

2. When compacted thickness of drainage course is 150 mm or less, place materials in a single layer.

3. When compacted thickness of drainage course exceeds 150 mm, place materials in equal layers, with no layer more than 150 mm thick or less than 75 mm thick when compacted.

FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test sub grades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Foundation and Footing Sub grades: At foundation and footing sub grades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing sub grades may be based on a visual comparison of sub grade with tested sub grade when approved by the Engineer.

D. Testing agency will test compaction of soils in place according to ASTM D 698, ASTM D 1556, ASTM D 1557, ASTM D 2167, ASTM D 2922, ASTM D 2937, ASTM D 4429, and AASHTO T 180, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At sub grade and at each compacted fill and embankment layer, at least one test for every 200 sq. m or less of each type of paved area or building slab, but in no case fewer than three tests.

2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 30 m or less of wall length, but no fewer than two tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 50 m or less of trench length, but no fewer than two tests.

E. When testing agency reports that backfills, fills, sub grades, or embankments have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace with satisfactory soil to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. **Protecting Graded Areas:** Protect newly graded areas from traffic, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially

completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by the Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. **Disposal:**

a. Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and dispose of at designated spoil areas on the Employer's property (disposal area will be within a 6-km proximity to the construction area)..

b. Transport surplus satisfactory soil to designated storage areas on Employer's property. Stockpile or spread soil as directed by the Engineer.

1. Remove waste material, including unsatisfactory soil, trash, and debris, and dispose of at designated spoil areas on the Employer's property (disposal area will be within a 6-km proximity to the construction area).

SECTION 3 - TERMITE CONTROL

PART 1 – GENERAL

A. General provisions of the Contract, including Conditions of Contract apply to this Section.

1.1 SUMMARY

A. This Section includes the following for termite control:

1. Termite prevention
2. Soil treatment
3. Wood protection

1.2 TERMITE PREVENTION

A. Avoid creation of conditions that invite termites wherever possible. Take the following measures:

1. Remove stumps, roots, wood, and other cellulose materials from the building site before commencing construction.
2. Remove cellulose materials from around the foundation before final backfill.
3. Promptly remove form boards and grade stakes used in construction from site.
4. Allow no contact between building woodwork and soil or fill material.
   a. Locate exterior woodwork a minimum of 15 cm above ground and beams in crawl spaces at least 45 cm above ground to provide ample space to make future inspections.
   b. Make foundation areas accessible for inspection if possible.
   c. If wood that contacts the soil, such as fence posts and foundation elements, use pressure treated wood.
5. Design ventilation openings in foundations to prevent dead air pockets and to help keep the ground dry.
6. Direct water away from the structure through proper grading.
7. Assure that the roof drainage system directs all water away from the foundation.
8. Avoid plantings near the foundation. Any tree that has the potential to grow to a height of 12 meters or taller shall not be planted within 15 meters of the foundation.

1.3 DEFINITIONS

A. EPA: United States Environmental Protection Agency.

B. PMP: Pest Management Professional

1.4 SUBMITTALS

A. Product Data: For termiticide and borate.

1. Include the EPA-Registered Label for termiticide and borate products.

B. Product Certificates: For termite control products, signed by product manufacturer.

C. Qualification Data: For Installer of termite control products.

D. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Brand name and manufacturer of termiticide.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes, and rates of application used.
6. Areas of application.
7. Water source for application.

E. Wood Treatment Application Report: After application of borate is completed, submit report for Owner's record information, including the following:

1. Date and time of application.
2. Brand name and manufacturer of borate.
3. Quantity of undiluted borate used.
4. Dilutions, methods, volumes, and rates of application used.
5. Areas of application.

F. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A PMP who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located and who is experienced and has completed termite control treatment similar to that indicated for this

Project and whose work has a record of successful in-service performance.

B. Regulatory Requirements: Formulate and apply termiticide, and label with a US EPA registration number, to comply with EPA regulations and authorities having jurisdiction.

C. Document any applicable local codes or authorities and ensure that all relevant work is in compliance.

D. Implement applicable provisions of the Quality Control program as established in Section 01401, "Contractor Quality Control."

1.6 PROJECT CONDITIONS

Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

Standard Guide for General Criteria Used for Evaluating Laboratory Competence

Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric)

Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

1.7 COORDINATION

A Coordinate soil treatment application with excavating, filling, and grading and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs, before construction

1.8 WARRANTY

A. Warranty: Written warranty, signed by applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, retreat soil and repair or replace damage caused by termite infestation.

A. Warranty Period: Five years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 TERMITICIDES

A. Soil Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or amusable, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation for review and acceptance by the COR.

1. The Department of State currently authorizes Termidor and Premise as soil termiticide.
2. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA Registered Label.

B. Wood Protection Termiticide:

1. Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation for review and acceptance by COR.
2. The Department of State currently authorizes TimBor and BoraCare for preventive wood treatment.
3. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA Registered Label.
4. Protect vegetation from contact with Timbor and BoraCare.

SECTION 4 - CONCRETE CURBS AND SIDEWALKS

PART 1 - GENERAL

1.1 Drawings and General Provisions of the Contract, including Conditions of Contract and Division 1 Specifications Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Pre-cast concrete curbs and units.

B. Related sections include the following:

1. Division 3: Section 03300 “Cast-in-place Concrete”.

1.3 SUBMITTALS

A. The Contractor shall submit for approval, samples of each of the proposed units together with the manufacturer’s certificates and details of the method of manufacture and materials to be used. The Engineer’s approval of the samples will not be considered final and the Engineer may reject any pre-cast units delivered to the Site, which do not, in his opinion, meet the required standards.

1.4 QUALITY ASSURANCE

A. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

B. Fabricator Qualifications: Shall comply with the following requirements:

1. Has sufficient production capacity to produce required units without delaying the work.

2. Is experienced in manufacturing pre-cast concrete curbs units and tiles similar to those indicated for this project and can demonstrate a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pre-cast units to Project Site in such quantities and at such times to ensure continuity of installation. Store units at Project-site in such a way as to prevent cracking or other physical damage.

PART 2 - PRODUCTS

2.1 CONCRETE

A. All concrete shall conform with the relevant requirements of Section 03300 - "Cast in-place Concrete" and shall be produced by an approved commercial ready-mix plant. All In-situ and pre-cast concrete shall have 28 days compressive strength on cylinder equal to 21 MPa, except base course and backing concrete which shall be 17 MPa with a maximum aggregate size equal to 60 mm.

B. Mortar shall conform with all relevant requirements of Section 03300 - " Cast-inplace Concrete ", and shall consist of cement and fine aggregate having the same proportions as that used in the concrete construction.

2.2 REINFORCEMENT

A. Reinforcing steel shall conform with the requirements of Section 03300 Part 2 Products: "Steel Reinforcement".

2.3 PRECAST CONCRETE UNITS

A. All pre-cast units shall be manufactured to the dimensions shown on the Drawings. Manufacturing tolerances shall be 3 mm in any one dimension. End and edge faces shall be perpendicular to the base.

B. Each pre-cast curb or gutter unit shall normally be 500 mm in length and this length shall be reduced to 250 mm or as directed, where units are to be installed along curves of less than 10 m radius.

C. For horizontal curves of radius less than 10 m, curb and gutter units shall be manufactured to the radius shown and in such circumstances straight elements or portions of straight elements shall not be used. Bullnoses and curved faces shall be of constant radius with a smooth change from radius to plain face.

D. Surfaces of pre-cast units that will be exposed to view after installation shall be true and even, with a dense finish of uniform texture and color, free from cracks, holes, fins, staining or other blemishes or defects. Units failing to meet these requirements will be rejected. Surfaces that will not be exposed to view after installation shall have all fins and irregular projections removed and all cavities, minor honeycombing and other defects made good with mortar after the units have been saturated with water for at least 3 hours.

E. Pre-cast units shall be cast upside down in approved steel molds under conditions of controlled temperature and humidity. The units shall be steam cured, or cured by another method approved by the Engineer, until the concrete attains the full specified 28-day strength.

2.4 PREFORMED EXPANSION JOINT FILLER

A. Preformed expansion joint filler shall conform to AASHTO M 33.

2.5 EPOXY ADHESIVE

A. Epoxy adhesive (for use in attaching pre-cast units to existing concrete pavement surfaces) shall be a 2 components epoxy of high viscosity and rapid setting characteristics, conforming to AASHTO M237, Class II.

2.6 DUCTS

A. Ducts (if required under sidewalks or medians) shall consist of uPVC plastic pipe conforming to ASTM D 2750, Type II. If jacking is required, duct shall be approved galvanized steel tube.

2.7 BEDDING

A. Bedding material shall conform to the relevant requirements of Section 02721 - "Aggregate Sub-base Course" for Class A or Class B granular material.

PART 3 - CONSTRUCTION AND INSTALLATION

3.1 CONSTRUCTION AND INSTALLATION

3.1.1 Pre-cast Concrete Curbs:

A. Forms for the concrete base shall be approved wood or steel. All forms shall be sufficiently strong and rigid and securely staked and braced to obtain a finished product correct to the dimensions, lines and grade required. Forms shall be cleaned and oiled before each use. If approved, forms for the concrete base may be omitted and the concrete placed directly against undisturbed excavated faces.

B. Base course concrete shall be placed, compacted and shaped to the sections shown on the Drawings. Concrete shall be compacted with an approved internal type vibrator or if approved, by hand spudding and tamping. Edges shall be rounded if necessary by the use of wood molding or by the use of an edger as applicable. The concrete base shall be finished to a true and even surface with a wood float. Concrete shall be membrane or water cured for at least 7 days before pre-cast units are placed thereon.

C. Pre-cast units shall be soaked in water immediately before installation. Units shall be set accurately in position in mortar on the concrete base. Joints between pre-cast units shall not be mortared unless otherwise shown on the Drawings. Units shall be closely spaced and every 10 m run shall be provided with an expansion joint.

D. Where curbs or gutters are installed on existing concrete pavement and using epoxy resin adhesive, the installation procedures shall conform with those specified for raised pavement markers in Section 02760 - "Airfield Marking ".

E. After curbs have been installed, steel forms shall be erected and concrete backing, if required, shall be placed as shown on the Drawings. Pavement courses shall not be laid against curbs until the concrete backing has membrane or water cured for at least 14 days.

3.2 ERECTION TOLERANCE

A. Tolerances on tangent sections of curb and gutter shall be tested using a 4 m straightedge. The finished surface of concrete shall not deviate from the straightedge between any 2 contact points by more than 5 mm. Curved sections shall be true to the specified radius plus or minus 5 mm and all joints shall be flush and neat in appearance.

B. The area adjacent to completed and accepted curbs and gutters shall be backfilled with approved material to the top edges of the curbs or gutters or the elevations shown on the Drawings. Backfill shall be placed and compacted to 95% AASHTO T 180 maximum density.

C. The smoothness of paved areas shall be tested using a 4 m straightedge. The finished surface of concrete shall not deviate from straightedge between any two contact points by more than 5 mm. Sections of defective paving shall be removed and replaced as directed, at the Contractor’s expense.

3.3 FIELD QUALITY CONTROL

A. Remove and replace work that does not comply with specified requirements.

B. Additional testing and inspecting, at the Contractor’s expense, will be performed to determine compliance of corrected work with specified requirements.

3.4 REPAIRS

A. Repair pre-cast concrete curbs and tiles to match color, texture, and uniformity of surrounding pre-cast concrete curbs and tiles if permitted by the Engineer.

B. Remove and replace damaged pre-cast concrete curb units and tiles if repairs do not comply with requirements.

SECTION 5 - UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Concrete pavers set in aggregate setting bed.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for compacted sub grade and sub base course, if any, under unit pavers.

1.3 SUBMITTALS

A. **Product Data:** For the following:

1. Concrete pavers.

B. **Samples for Initial Selection:** Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of unit paver indicated.

1. Include similar samples of material for joints and accessories involving color selection.

C. **Samples for Verification:** Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.

1. Provide samples with joints grouted and cured, showing the full range of colors to be expected in the completed Work.

D. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/Consultants and owners, and other information specified.

1.4 QUALITY ASSURANCE

A. **Installer Qualifications:** An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. **Source Limitations:** Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

C. **Mockups:** Before installing unit pavers, build mockups for each form and pattern of unit pavers required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the

completed Work, including same base construction, special features for expansion joints, and contiguous work as indicated:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by the Consultant.

2. Notify the Consultant 7 days in advance of dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain the Consultant's approval of mockups before starting unit pavers installation.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

6. Demolish and remove mockups when directed.

7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.

1. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.

PART 2 - PRODUCTS

2.1 COLORS AND TEXTURES

A. **Colors and Textures:** As shown on drawings and as selected by the Consultant from the manufacturer’s full range.

2.2 UNIT PAVERS

A. **Concrete Pavers:** Solid, interlocking paving units, ASTM C 936, made from normal-weight aggregates in sizes and shapes indicated. Interlocking Paving should be installed on 30-50 mm thick sand setting bed over 250 mm thick sub-base. The minimum thickness of concrete pavers shall be 60mm. Concrete pavers shall be tested for compressive strength, abrasion resistance, absorption and dimensional tolerance. The test results shall comply with the requirements specified in ASTM C 936.

2.3 ACCESSORIES

A. **Precast Concrete Edge Restraints:** Precast concrete curbing, made from normal-weight aggregate, in shapes and sizes indicated.

2.4 AGGREGATE SETTING-BED MATERIALS

A. **Graded Aggregate for Sub base:** Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57.

B. **Graded Aggregate for Sub base:** ASTM D 2940, sub base material.

C. **Graded Aggregate for Base:** Sound crushed stone or gravel complying with ASTM

D 448 for Size No. 8.

D. **Graded Aggregate for Base:** ASTM D 2940, base material.

E. **Geotextile:** Woven or non-woven geotextile manufactured from polyester or polypropylene fibers, with a permeability rating 10 times greater than that of soil on which paving is founded and an apparent opening size small enough to prevent passage of fines from leveling course into graded aggregate of base course below.

F. **Sand for Leveling Course:** Sound, sharp, washed natural sand or crushed stone complying with gradation requirements of ASTM C 33 for fine aggregate.

G. **Stone Screenings for Leveling Course:** Sound stone screenings complying with ASTM D 448 for Size No. 10.

H. **Sand for Joints:** Fine, sharp, washed natural sand or crushed stone with 100 percent passing 1.18 mm sieve and no more than 10 percent passing 0.075 mm sieve.

1. Provide sand of color needed to produce required joint color.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with the Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Where pavers are to be installed over waterproofing, examine waterproofing installation, with the waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

A. Vacuum clean concrete substrates to remove dirt, dust, debris, and loose particles.

B. Remove substances, from concrete substrates, that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

C. Proof-roll prepared sub grade surface to check for unstable areas and areas requiring additional compaction. Proceed with unit paver installation only after deficient sub grades have been corrected and are ready to receive sub base for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. **Joint Pattern:** Herringbone.

E. **Pavers over Waterproofing:** Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler, at waterproofing that is turned up on vertical surfaces; or, if not indicated, provide temporary filler or protection until paver installation is complete.

F. Tolerances: Do not exceed 0.8 mm unit-to-unit offset from flush (lippage) nor 3 mm in 3 m from level, or indicated slope, for finished surface of paving.

3.4 AGGREGATE SETTING-BED PAVER APPLICATIONS

A. Compact soil sub grade uniformly to at least 95 percent of ASTM D 1557 laboratory density.

B. Place geotextile over prepared sub grade, overlapping ends and edges at least 300 mm.

C. Place aggregate sub base in thickness indicated. Compact by tamping with plate vibrator and screed to depth required to allow setting of pavers.

D. Place aggregate sub base over compacted sub grade. Provide compacted thickness indicated. Compact sub base to 100 percent of ASTM D 1557 maximum laboratory density and screed to depth required to allow setting of pavers.

E. Place geotextile over compacted base course, overlapping ends and edges at least 300 mm.

F. Place leveling course and screed to a thickness of 25 to 38 mm, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

G. Treat leveling base with soil sterilizer to inhibit growth of grass and weeds.

H. Set pavers with a minimum joint width of 1.6 mm and a maximum of 3 mm, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 10 mm with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

I. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 16- to 22 kN compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.

2. Before ending each day's work, fully compact installed concrete pavers to within 900 mm of the laying face. Cover open layers with non-staining plastic sheets overlapped 1200 mm on each side of the laying face to protect it from rain.

J. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

K. Do not allow traffic on installed pavers until sand has been vibrated into joints.

L. Repeat joint-filling process 30 days later.

3.5. REPAIR

Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

SECTION 6: CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

B. Cast-in-place concrete includes, but is not limited to, the following:

1. Foundations and footings.
2. Drilled piers
3. Slabs-on-grade
4. Fill for steel deck
5. Walls
6. Duct banks.
7. Equipment pads and bases.
8. Fill for steel pan stairs.
9. Landscape concrete paving for walkways and bands.
10. Others.

C. **Related Sections:** The following sections contain requirements that relate to this section:

1. Division 2 Section "Earthwork" for drainage fill under slabs-on-grade.
2. Division 3 Section "Lightweight Concrete Roof Insulation" for cast-in-place lightweight concrete roof insulation.
3. Division 5 Section, "Steel Deck" for steel deck construction.
4. Division 7 “Joint Sealants”.

D. The structural concrete elements shall be designed in accordance to the following codes and regulations:

1. 1997 Uniform Building Code.
2. Building Code Requirements for structural Concrete (ACI-318M-02) and Commentary (ACI 318RM-02).

E. The Contractor is to carry out the structural design of the various project components following the basic design criteria stated in article 1 .2D.

DEFINITIONS

Cementitious Materials: Portland cement alone or in combination with silica fume.

REFERENCES

American Association of State Highway and Transportation Officials (AASHTO):

AASHTO M182 Standard Specification for Burlap Cloth Made from Jute or

AASHTO T26 Standard Method of Test for Quality of Water to be used in Concrete

American Concrete Institute (ACI):

ACI 117	Specifications for Standard Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305	Hot Weather Concreting
ACI 309	Guide for Consolidation of Concrete
ACI 315	Standard Practice for Detailing Reinforced Concrete Structures
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Formwork for Concrete
ACI 504R	Guide to Joint Sealants for Concrete Structures

C. American National Standards Institute (ANSI):

ANSI Q9001	Quality Systems – Model for Quality Assurance in Design, Development, Production, Installation, and Servicing
ANSI Q9002	Quality Systems – Model for Quality Assurance in Production, Installation, and Servicing

D. American Society for Testing and Materials (ASTM):

ASTM A 82	Standard Specification for Steel Wire Reinforcement, Plain, for Concrete
ASTM A 185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 496	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615M	Standard Specification for Deformed and Plain Billet- Steel Bars for Concrete Reinforcement
ASTM A 706M	Standard Specification for Low-Alloy Steel Deformed and Plain Bars
ASTM A 775/A775M	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A 780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM A 820 Standard Specification for Steel Fibers for Fiber-Reinforced Concrete

ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C 33 Standard Specification for Concrete Aggregates

ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C 40 Standard Test Method for Organic Impurities in Fine Aggregates for Concrete

ASTM C 42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C 88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C 94 Standard Specification for Ready-Mixed Concrete

ASTM C 114 Standard Test Methods for Chemical Analysis of Hydraulic Cement

ASTM C 117 Standard Test Method for Materials Finer Than 75-Micrometer (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C 127 Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

ASTM C 128 Standard Test Method for Density, Relative Density Specific Gravity) and Absorption of Fine Aggregate

ASTM C 131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C 142 Standard Test Method for Clay Lumps and Friable Particles in Aggregates

ASTM C 143 Standard Test Method for Slump of Hydraulic Cement Concrete

ASTM C 150 Standard Specification for Portland Cement

ASTM C 171 Standard Specification for Sheet Materials for Curing Concrete

ASTM C 172 Standard Practice for Sampling Freshly Mixed Concrete

ASTM C 186 Standard Test Method for Heat of Hydration of Hydraulic Cement

ASTM C 191 Standard Test Method for Time of Setting of Hydraulic Cement

ASTM C 192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 219 Standard Terminology Relating to Hydraulic Cement

ASTM C 227 Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)

ASTM C 289 Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)

ASTM C 295 Standard Guide for Petrographic Examination of Aggregates for Concrete

ASTM C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C 311 Standard Test Methods for Sampling and Testing Fly Ash or Natural

Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete

ASTM C 330 Standard Specification for Lightweight Aggregates for Structural Concrete

ASTM C 494 Standard Specification for Chemical Admixtures for Concrete

ASTM C 586 Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)

ASTM C 595 Standard Specification for Blended Hydraulic Cements

ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

ASTM C 881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

ASTM C 920 Standard Specification for Elastomeric Joint Sealants

ASTM C 989 Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

ASTM C 1064 Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete

ASTM C 1077 Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

ASTM C 1105 Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction

ASTM C 1116 Standard Specification for Fiber-Reinforced Concrete and Shotcrete

ASTM D 209 Standard Specification for Lampblack Pigment

ASTM D 512 Standard Test Methods for Chloride Ion in Water

ASTM D 516 Standard Test Method for Sulfate Ion in Water

ASTM D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types

ASTM D 3963/D 3963M Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars

ASTM E 154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

ASTM E 329 Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

ASTM E 548 Standard Guide for General Criteria Used for Evaluating Laboratory Competence

ASTM E 1155M Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric)

ASTM E 1745 Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

E. British Standards:

BS 812	Testing Aggregates
BS 882	Specification for Aggregates from Natural Sources for Concrete
BS 1881	Methods of Testing Concrete
BS 1199 and 1200	Specification for Building Sands from Natural Sources
BS 4027	Specification for Sulfate-Resisting Portland Cement
BS 4449	Specification for Carbon Steel Bars for the Reinforcement of Concrete
BS 4483	Steel Fabric for the Reinforcement of Concrete
BS 5328	Methods for Specifying Concrete Including Ready-Mixed Concrete
BS 8007	Code of Practice for Design of Concrete Structures for Retaining Aqueous Liquids
BS 8110	Structural Use of Concrete Part 1 (1997): Code of Practice for Design and Construction, Part 2 (1985): Code of Practice for Special Circumstances, Part 3 (1985): Design Charts for Singly Reinforced Beams, Doubly Reinforced Beams and Rectangular Columns
BS 8666	Specification for Scheduling, Dimensioning, Bending and Cutting of Steel Reinforcement for Concrete
EN 197	Part 1: Cement. Composition, Specifications and Conformity Criteria for Common Cements

F. Commercial Standards (CS):

Concrete Plant Manufacturers Bureau - Concrete Plant Standards

National Ready-Mixed Concrete Association (NRMCA) - Check List

G. Concrete Reinforcing Steel Institute (CRSI):

CRSI Manual of Standard Practice

H. Corps of Engineers (CE):

CE CRD-C119 Test for Flat and Elongated Particles

CE CRD-C300 Curing Compound

CE CRD-C513 Rubber Waterstops

CE CRD-C572 PVC Waterstops

I. National Standard of Canada:

CAN/CSA A23.5 - M86 Supplementary Cementing Materials

1.5 SUBMITTALS

A. The Contractor's design deliverables should include but not limited to the following:

- Detailed structural working drawings for concrete items showing the general arrangement, elevations, plans, sections and connection and reinforcement details.

- Fully detailed structural calculation showing statical system, computer models, including input file data, using reputable software, and clear graphical illustration of straining actions, deformations along with design of all sections. The design calculations should abide by the design codes and design criteria mentioned in article 1.2D with clear reference to the grade of materials to adopt in the construction in light of the actual availability so that the later substitution are to be restricted.

B. **Steel Reinforcement Shop Drawings:** Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

C. **Formwork Shop Drawings:** Prepare shop drawings for formwork indicating fabrication and erection of forms for specified finish concrete surface. Show form construction including jointing, especial form joints or reveals, location and pattern of form tie placement. Prepare formwork drawings by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. The Engineer's review is for general architectural applications and features only. Design and engineering of formwork for structural stability and efficiency are the Contractor's responsibility.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.

D. **Product Data:** For proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by the Engineer.

E. **Design Mixes:** For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

F. **Welding Certificates:** Copies of certificates for welding procedures and personnel.

G. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and any other information required by the Engineer.

H. **Material Test Reports:** From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

I. **Material Certificates:** Signed by manufacturers and contractor certifying that each of the following items complies with specified requirements:

1. Cementitious materials and aggregates.

2. Form materials and form-release agents.

3. Steel reinforcement and reinforcement accessories:

A copy of the manufacturer's test certificate for ultimate strength, elongation and cold bending, together with the chemical analysis of the steel shall be submitted to the Engineer for each consignment of reinforcing steel delivered to the Project site.

4. Fiber reinforcement.

5. Admixtures:

   Material certificates in lieu of material laboratory test reports when permitted by the Engineer. Material certificates shall be signed by the manufacturer and the Contractor, certifying that each material item complies with specified requirements. Provide certification from admixture manufacturers that chloride content complies with specified requirements.

6. Waterstops.

7. Curing materials.

8. Floor and slab treatments.

9. Bonding agents.

10. Adhesives.

11. Vapor retard ers.

12. Epoxy joint filler.

13. Joint-filler strips.

14. Repair materials.

J. **Samples:** Samples of materials as requested by the Engineer, with names, sources, and descriptions, including, but not limited to, the following:

1. Color finishes.

2. Normal-weight aggregates.

3. Reglets.

4. Waterstops, reinjectable hosing, water swelling gaskets.

5. Vapor retarder/barrier.

6. Form liners.

7. Joint fillers.

8. Sealants.

K. Minutes of pre-installation conference.

1.6 STRUCTURAL DESIGN CONSIDERATION

A. **General:** Based upon the architectural configuration and the respective structural performance criteria, the Contractor is to carry out the design of the involved RC structures. All design codes, design loads, material types, precautions and

considerations mentioned throughout section 03300 shall apply to all designed items. The load of actual electromechanical installations, architectural finishes and suspended doors, partitions and local curtain walls are to be considered in the design after coordination with the suppliers. The actual soil characteristics are to be adopted in designing the RC substructure.

B. **Design Concept:** The structural design concept must be based on functional, economical and efficient systems. The systems adopted are to be chosen to fulfill the specific architectural requirements, in addition to any other requirements related to utilities and services.

C. **Design Codes:** The structural concrete elements shall be designed in accordance to the following codes and regulations.

1. 1997 Uniform Building Code

2. Building Code Requirements for Structural Concrete (ACI-318-02) and Commentary (ACI 318-02).

D. **Load Combinations:** The most Critical Load Combination shall govern the design of structural members including combinations of lateral and secondary loads.

E. **Materials:** The materials used shall be in accordance with the requirements of Parts 2 and 3 of this specification.

F. **Structural Analysis:** Where structural computer analyses are used, they should be carried out using well known software. Moreover, the Contractor might be asked to submit the user and verification manuals of computer programs used.

G. Foundations and Substructure.

1. Foundation Types

The chosen foundation system must satisfy two basic criteria. First, the soil beneath the foundations must have an adequate shear strength to support the maximum loads with an appropriate factor of safety. Second, the expected total and differential settlements, as well as angle of tilt, must be within the allowable limits.

In case of adopting shallow foundations, the following limits should be respected when calculating the allowable bearing pressures under sustained loading conditions:

- Factor of safety against shear failure ≥2.5
- Allowable total settlement for footings: ≤25 mm
- Allowable total settlement for raft: ≤50 mm
- Allowable angle of tilt: ≤1/500

When calculating the angle of tilt for a structure, the differential settlement could be taken equal to 75% of the total settlement in case of footings and 35% of the total settlement in case of raft.

In case of special structures, the foundation type and allowable bearings pressure could be dictated by special architectural and/or mechanical requirements for total and differential settlement, as well as angle of tilt, if any.

Nom-uniform stress distribution underneath footings should satisfy the following criteria.

For the cases of loading involving sustained loads only, a triangular stress distribution is not allowed; the full area of the footing under consideration should be subjected to compressive stresses.

For the cases of loading involving dead load and wind/earthquake loads, triangular stress distributions are allowed provided that the area of the footing subjected to compression is not less than 50% of the total footing area.

Blinding concrete with thickness 50 mm to 100 mm has to be provided underneath all sub-structural elements and slabs on grade.

Edges of all sub-structural elements are to be chamfered (20 x 20 mm).

On the other hand, the use of pile foundations could be necessary if dictated by the geotechnical report, (prepared by the Contractor).

Structural Design of Retaining Walls

When used, retaining walls must be designed to resist the earth pressure, and expected surcharge considering the angle of friction, according to geotechnical report.

The following safety factors shall be used to check the overall stability.

- Factor of safety against sliding ≥1.5
- Factor of safety against overturning ≥1.5

Foundation Protection

Based on the geotechnical conditions at the project site and the chemical analyses conducted on soil and water, the ground is expected to the chemically aggressive with high sulphate and chloride contents. Sulphates in the water were at 4.3 gm/l and in solid at 1.93 gm/l. Chlorides in the water were at 14.54% and in solid at 0.08%. Adequate protection measures against chemical attack should be taken for the foundations concrete/reinforced concrete.

1.7 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

B. **Codes and Standards:** Comply with 2001 Manual of Concrete Practice Parts 1, 2, 3, 4 & 5, and CRSI "Manual of Standard Practice" except where more stringent requirements are shown or specified.

C. **Concrete Quality Control Engineer:** Appoint a full-time Concrete Quality Control Engineer (CQCE) to ensure that concrete is properly produced, placed, cured and protected. The CQCE shall be equivalent to a Member of the Institute of Concrete Technology (MICT) and shall be responsible for the maintenance and submission of all specified records. The CQCE shall not report to his own company's site construction management but to his own company's management and to the Engineer. The CQCE shall set standards of quality and insist that these standards be followed, prepare a Quality Control Program for the inspection and testing of concrete and the maintenance of all reports and records to meet the specified requirements and requirements of the Engineer.

1. The CQCE shall be authorized to:

a. Postpone concreting operations until outstanding requirements are corrected.

b. Reject materials or workmanship that do not conform to this Specification.

c. Prevent the use of equipment that could cause improper construction relative to this Specification.

d. Stop any work that is not being done in accordance with specified requirements.

e. Report within 24 hours and provide records to and as required by the Engineer upon discovery of non-compliance.

D. The Contractor shall operate a Quality Assurance System in accordance with ANSI Q9002. This Quality Assurance Manager shall be responsible for the preparation of a Quality Plan for approval of the operations specified in this Section. The Quality Plan shall include, among other things, the list and schedule of the Quality Control audits that the Quality Assurance Manager or his designee shall make.

E. **Concrete Manufacturer Qualifications:** A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94/C94M requirements for production facilities and equipment.

F. Engage an independent testing agency acceptable to the Engineer to perform material evaluation tests and qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548 and to design concrete mixes.

1. Personnel conducting field tests shall be qualified as ACI concrete field testing technician, Grade 1 according to ACI CP-1 or an equivalent certification program.

G. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at the Contractor’s expense.

H. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

I. **Welding:** Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

J. **Mockups:** Before casting concrete that is exposed to view on surfaces of the completed structure or building, cast a mockup for each exposed element, including slabs if applicable, to demonstrate typical joints, surface finish, texture, color, tolerances, quality of materials and standard of workmanship in the completed Work.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by the Engineer.

2. Notify the Engineer seven days in advance of dates and times when mockups will be constructed.

3. In the presence of the Engineer, damage parts of exposed surfaces as selected by the Engineer, and demonstrate materials and techniques proposed for repairs to match adjacent undamaged surfaces.

4. Obtain the Engineer's approval of mockups before starting cast-in-place concrete elements exposed to view.

5. If the Engineer determines that any mockup does not meet requirements, demolish and remove from the site and cast another until the mockup is approved.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

7. Demolish and remove mockups when directed.

K. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements as follows:

1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

a. Contractor's superintendent.

b. Agency responsible for concrete design mixes.

c. Agency responsible for field quality control.

d. Ready-mix concrete producer.

e. Concrete subcontractor.

f. Primary admixture manufacturers.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

1. Avoid damaging coatings on steel reinforcement.

2. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

PART 2 – PRODUCTS

2.1. FORM MATERAIL

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.

1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.

2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. **Forms for Unexposed Finish Concrete:** Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

C. **Forms for Textured Finish Concrete:** Units of face design, size, arrangement, and configuration to match the Engineer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

D. **Forms for Cylindrical Columns and Supports:** Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

E. **Form Release Agent:** Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form release agent with rust inhibiters for steel facing materials.

F. **Form Ties:** Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that shall leave no metal closer than 38 mm to the plane of the exposed concrete surface. No permanent metallic part shall have less concrete cover than the reinforcement. Provide ties that, when removed, will not leave holes larger than 25 mm in diameter in the concrete surface. Furnish ties with integral water-barrier plates to walls indicated to receive damp-proofing or waterproofing.

G. **Chamfer Strips:** Wood, metal, PVC, or rubber strips 20 mm x 20 mm, size as indicated on drawing.

2.2 STEEL REINFORCEMENT

A. **Reinforcing Bars:** ASTM A 615M, Grade 60 (420 MPa) specified yield strength, or BS 4449 grade 460 Type 2 deformed, uncoated. One test per 5000 m length delivered to site.

B. **Plain-Steel Wire:** ASTM A 82, as drawn.

C. **Welded Wire Fabric:** ASTM A 185, welded steel wire fabric.

D. Only new material shall be furnished. On receipt and at time of installation, material shall be free of loose rust and loose mill scale, deleterious amounts of salts and coatings that reduce or destroy bond. Tight rust and mill scale or surface irregularities are acceptable if the weight and dimensions, including height of deformations and tensile properties, of a test specimen that has been wire-brushed by hand, are not less that those required by the applicable Standards.

E. Reinforcement shall be accurately bent, cut or formed to the dimensions and configuration shown on Drawings and within the tolerances specified in ACI 315. Reinforcement shall be bent cold using pin sizes in accordance with ACI 318. Bars may be preheated only if prior approval has been requested and received. Reinforcement shall not be rebent or straightened without prior approval.

1. Reinforcement having a reduced section, kinks, visible transverse cracks at bends, or otherwise damaged in any way shall not be used. Galvanized steel shall not be used for reinforcement.

2. Reinforcement shall not be welded unless specifically shown on Drawings or permitted as an exception and then only after approval of the welding method appropriate to the grade of steel and the type of welding rod to be used.

2.3 REINFORCEMENT ACCESSORIES

A. **Bar Supports:** Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.

2. Other reinforcement supports shall consist of concrete spacer blocks made of the same materials, to the same specified requirements and with the same inherent properties as the parent material with the exception that the maximum aggregate size shall be appropriate for the thickness of cover to the reinforcement.

B. **Joint Dowel Bars:** Plain-steel bars, ASTM A 615M, Grade 60 (420 MPa). Cut bars true to length with ends square and free of burrs.

C. Mechanical Splices (Couplers) of deformed high yield steel bars are to consist of two seamless steel sleeves and interconnecting high tensile steel stud with plastic protection caps for threaded section of sleeve. To be tested and the test to exceed 135% of the specified yield strength of grade 60 bar.

2.4 CONCRETE MATERIALS

A. **Portland Cement:** Cement shall be low alkali with chemical composition in accordance with Table 1 of ASTM C 150 or EN 197: Part 1. The magnesia content shall be limited to 4 percent by weight of cement, as tested in accordance with ASTM C 114. Use one brand of cement throughout Project unless otherwise approved by the Engineer. Manufacturer’s test certification shall be supplied for each delivery of cement and shall confirm that the cement complies with the above requirements and shall be submitted by the Contractor not later than the day of delivery of the cement. The Engineer shall have the right to call for tests, the cost of which are to be borne by the Contractor, on each delivery of cement to confirm that the cement meets the following requirements.

1. Use Ordinary Portland Cement (OPC) conforming to ASTM C 150, Type I. Cement meeting the requirements of rapid hardening Portland cement shall not be used and the heat of hydration shall not exceed 325 kj/kg when tested in accordance with ASTM C 186. C3A content shall be a maximum of 8 percent by weight as tested in accordance with ASTM C 114.

2. Moderate sulphate: According to ASTM C150 type II.

3. Sampling shall be carried out in accordance with EN 196: Part 7.

4. Test cement for fineness by air permeability apparatus in accordance with ASTM C 204 to meet the requirements of ASTM C 150.

5. Test cement for soundness, Autoclave expansion in accordance with ASTM C151.

6. Use white Portland cement in concrete for columns supporting polished precast concrete panel.

B. **Silica Fume:** Silica fume (SF) used as a cement replacement shall be in

accordance with Type U, specified in Canadian National Standard CAN/CSA-A23.5 - M86. There shall be a 5 percent replacement of the OPC. The silica fume shall be obtained from an approved supplier.

1. The approved supplier shall provide documentation to establish the following:

   a. That the silica fume complies with Type U of CAN/CSA-A23.5 - M86.

   b. The silica fume results from the production of silicon or ferro-silicon alloys containing at least 85 percent silicon.

   c. That source of supply shall remain the same for the construction period of the project.

   d. That the supply shall be adequate to meet the anticipated peak requirement.

   e. Chemical analyses to give the percentages of the following materials:

Si 02	C
Ca 0	Fe2 03
Al2 03	Na2 0
K2 0	Mg 0
S03	

   e. Loss on ignition.

   f. Percentage of particles greater than 44 mm.

   g. Specific surface area and method of test, together with corresponding particle size.

2. Delivery of silica fume to the concrete batching plant shall be in dry powder form, with a bulk density between 200 and 650 kg/cu. m.

3. Manufacturer's test certification shall be supplied for each delivery of silica fume and shall confirm that the silica fume complies with the above requirements and shall be submitted by the Contractor no later than the day of delivery of the silica fume.

4. The Engineer shall have the right to call for tests, the cost of which are to be borne by the Contractor, on each delivery of silica fume, if necessary to establish or confirm that the silica fume meets the above requirements.

C. **Normal-Weight Aggregates:** Aggregates shall be from approved sources and shall conform to the requirements of ASTM C 33 and BS 882. Petrographic analyses shall be made in accordance with ASTM C 295. Aggregates for exposed concrete shall be from a single source and shall not contain substances that cause spalling. Only aggregates not susceptible to alkali aggregate reaction shall be used. The Contractor shall supply samples of the materials for approval by the Engineer and each aggregate source shall be subject to monitoring by the Engineer. Grading of aggregate shall be to the completion of BS 882.

1. Coarse Aggregate: Coarse aggregate size shall be 20 mm nominal and those retained on a 5mm sieve and shall consist of crushed or uncrushed gravel or crushed stone and shall be selected, recrushed, finish screened and washed with water meeting the requirements of Paragraph 2.4 as necessary to comply

with the following:

Frequency of Tests	Test Description	Standard	Limit
Initial	Los Angeles Abrasion Loss (Grading A or B)	ASTM C 131	25% maximum
Initial	Ratio of Los Angeles Abrasion Loss at 100 & 500 Revolutions (100/500 Revolutions Value)	ASTM C 131 Note 6	0.25% maximum
1 per day	Clay Lumps and Friable Particles	ASTM C 142	1.0% maximum
1 per day	Material Finer than 75 Microns	ASTM C 117	1.0% maximum
1 per 7 days	Water Absorption	ASTM C 127	2.0% maximum
1 per 3 days	Chlorides as Cl	BS 812	0.03% maximum
1 per 3 days	Sulfates as SO3	BS 812	0.3% maximum
1 per 30 days	Magnesium Sulfate Soundness Loss (5 cycles)	ASTM C 88	5.0% maximum
1 per 3 days	Flakiness Index	BS 812	25% maximum
1 per 3 days	Elongation Index	BS 812	25% maximum
	Reactive Silica	ASTM C 227	Per Appendix X1.3.7 of ASTM C 33
1 per 7 days	Specific gravity		Minimum 2.6
1 per 2 days	Moisture Content		

* Additionally, limits specified in Paragraph 2.12.H for the total salt content of concrete shall not be exceeded.

2. Fine Aggregate: Fine aggregate, those passing a 5mm sieve, shall consist of crushed gravel, crushed stone or natural sand with rounded or surrounded particles and shall be washed as necessary to comply with the following:

Test Description	Standard	Limit
Clay Lumps and Friable Particles	ASTM C 142	1.0% maximum

Material Finer than 75 Microns	ASTM C 117	maximum 3% for natural sand and 51 for crushed sand with no plastic fines
Water Absorption	ASTM C 128	1.0% maximum
Chlorides as Cl	BS 812	0.06% maximum
Sulfates as SO3	BS 812	0.30% maximum
Organic Impurities	ASTM C 40	Lighter than Standard

* Additionally, limits specified in Paragraph 2.12 for the total salt content of concrete shall not be exceeded.

3. Certification: Obtain from each proposed source of supply Test Certification to confirm that the aggregates comply with the above requirements. The following information shall be provided:

   a. Quarry location.
   b. Aggregate type.
   c. Petrographic analysis report.
   d. Grading curve.
   e. Shape and surface texture.
   f. Flakiness index.
   g. 10 percent fines value.
   h. Impact test.
   i. Shell content.
   j. Chloride and sulfate content.
   k. Relative density.
   l. Water absorption value and moisture content.
   m. Silt, clay, and dust content.
   n. Results of reactive silica tests.
   o. Organic impurities (fine aggregate only).

4. Testing:

   a. When a source of supply for each aggregate type had been established, samples of materials delivered to Project site shall be taken for testing in accordance with BS 812 as follows:

      1) Tests for clay, silt and dust, and sieve analysis shall be carried out for every 20 tons of fine aggregate and every 40 tons of coarse aggregate.

      2) Chemical analyses shall be carried out on every 100 tons of aggregate.

   b. The Engineer shall have the right to call for additional samples at any

time for testing of aggregates delivered to the Project site or of aggregates at the source of supply in order to confirm that the aggregates meet the above requirements.

5. Transportation: During transportation to the Project site, all aggregates shall be protected from wind-borne contaminants. If these contaminants are present at time of delivery to the Project site, then the aggregates shall be washed with water meeting the requirement of Paragraph 2.4.F. Transport vehicles shall be cleaned of possible contamination due to previous use.

6. Storage: Aggregates shall be stored (under shade) on hard concrete floors or other approved materials having sufficient slope to ensure adequate drainage of aggregate before being used for concrete and each size and type shall be stored in separate heaps without intermixing. Storage shall prevent contamination of the aggregates by foreign material including wind blown dust. Fine and coarse aggregates shall be separated by permanent substantial partitions. Methods of storing, shading and cooling aggregates shall be approved by the Engineer.

D. **Water:** Water used for mixing concrete, ice production, washing and cooling aggregates, and curing concrete shall be free from impurities, oil, acid, salts, alkali, organic matter, and other potentially deleterious substances in accordance with AASHTO T26 and when tested in accordance with ASTM D 512 and ASTM D 516. Additionally, the limits specified in Paragraph 2.12.H for the total salt content of the concrete shall not be exceeded.

1. Once a source of satisfactory supply has been established, further tests shall be made daily with a portable electrical conductivity probe calibrated against the satisfactory supply. If the conductivity exceeds that of the satisfactory supply, then further chemical tests shall be performed.

E. **Lightweight Aggregate:** ASTM C 330.

1. Nominal Maximum Aggregate Size: 20 mm.

2.5 ADMIXTURES

A. Admixtures containing Chlorides shall not be used.

B. **General:** No admixture shall be used in the concrete without the Engineer's written approval and under no circumstances shall admixtures containing chlorides or other corrosive agents be allowed. Admixture compatibility with the type of cement used shall be proven.

C. The Contractor shall perform a trial batch and casting to substantiate the manufacturer’s claims of workability, retardation and air entrainment (0 to 1.0 percent maximum), as specified in Article 2.14. Admixtures shall comply with the following standards: ASTM C494/C494 M, EN 934 and EN 480. Also, admixture shall comply with EN 12878 for pigments of cement.

D. **Air-Entraining Admixture:** No air entraining agent shall be used.

E. Admixtures shall be incorporated into the mix design strictly in accordance with the manufacturer’s written instructions.

F. **High-Range Water-Reducing Admixture (Superplasticizer):** ASTM C 494, Type G.

1. If necessary, and only with the Engineer’s approval, a naphthalene sulphonate retarding superplasticizer shall be used to increase workability of

the concrete and retard the initial set.

2. Products: To produce fluid concrete with a slump value at least 200 mm, easily flowing, but at the same time free from segregation and having the same water/cement ratio as that of a no slump concrete with admixture. The product shall result in concrete that remains workable for a minimum of 3 hours at +20 deg.C and for a minimum of 1 hour at +40 deg..

3. Obtain from the retarding superplasticiser supplier, details of the material for review by the Engineer and confirmation that it is in accordance with specified requirements. Confirmation shall be obtained that the retarding superplasticiser is compatible with any pozzolan that is used.

4. Glare-Reducing Agent: For landscape concrete paving, provide material for reducing glare. Comply with ASTM D 209.

G. **Water-Reducing Admixture (Plasticizer):** ASTM C 494, Type A.

H. **Water-Reducing and Accelerating Admixture:** ASTM C 494, Type E.

I. **Water-Reducing and Retarding Admixture:** ASTM C 494, Type D.

J. **Corrosion-Inhibiting Admixture:** Commercially formulated, mixed cathodic and anodic inhibitor based on Amines and Alcohol; capable of forming a protective barrier and absorbed on the reinforcement surface of concrete for protecting steel bars and minimizing chloride reactions with steel reinforcement in concrete.

2.6 WATERSTOPS

A. **Waterstops:** Provide flat, waterstops at construction joints below earth level and or for water structures and other joints. Waterstops shall be sized to suit joints.

1. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricates corners, intersections, and directional changes.

a. Select profile from five subparagraphs below. Insert others if required.

b. Profile: Flat, dumbbell with center bulb.

c. Profile: Flat, dumbbell without center bulb.

d. Profile: Ribbed with center bulb.

e. Profile: Ribbed without center bulb.

f. Profile: As indicated.

B. **Self-Expanding Strip Waterstops:** Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material for adhesive bonding to concrete.

2.7 VAPOR RETARDERS, CURING COMPOUNDS AND FINISH

A. **Vapor Retarder:** ASTM E 1745, Class B, five-ply, nylon- or polyester-cord-reinforced, high-density polyethylene sheet; 0.25 mm thick.

B. **Related Materials:**

1. Polyethylene sheet not less than 8 units thick.

C. **Fine-Graded Granular Material:** Clean mixture of crushed stone, crushed gravel, and manufactured of natural sand; ASTM D 448, Size 10, with 100 percent passing a 4.75 mm sieve and 10 to 30 percent passing a 0.15 mm sieve; meeting deleterious substance limits of ASTM C 33 for fine aggregates.

D. **Sand Cushion:** Clean, manufactured or natural sand.

E. **Absorptive Cover:** Burlap cloth made from jute or kenaf weighing approximately 0.29 kg/sq. m and complying with AASHTO M182, Class 2.

F. **Moisture-Retaining Cover (Impervious Sheeting):** One of the following, complying with ASTM C 171:

1. Waterproof paper.

2. Polyethylene film.

3. Polyethylene-coated burlap.

G. **Evaporation Control:** Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

H. **Colored Wear-Resistant Finish:** Packaged dry combination of materials consisting of Portland cement, graded aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground non-fading mineral oxides interground with cement. Color shall be as selected by the Engineer from manufacturers' standards, unless otherwise indicated.

2.8 FLOOR AND SLAB TREATMENTS

A. **Slip-Resistive Aggregate Finish:** Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

B. **Un-pigmented Mineral Dry-Shake Floor Hardener:** Factory-packaged dry combination of Portland cement, graded quartz aggregate, and plasticizing admixture.

C. **Pigmented Mineral Dry-Shake Floor Hardener:** Factory-packaged dry combination of Portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Colors: Match the Engineer's samples.

2. Colors: As indicated by referencing manufacturer's designations.

3. Colors: As selected by the Engineer from manufacturer's full range for these characteristics.

D. **Penetrating Liquid Floor Treatment:** Chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

2.9 CURING MATERIALS

A. **Evaporation Retarder:** Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. **Absorptive Cover:** AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 305 g/sq. m when dry.

C. **Moisture-Retaining Cover:** ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. **Water:** Potable.

E. **Clear, Solvent-Borne, Membrane-Forming Curing Compound:** ASTM C 309, Type 1, Class B.

F. **Clear, Waterborne, Membrane-Forming Curing Compound:** ASTM C 309, Type 1, Class B.

G. **Clear, Waterborne, Membrane-Forming Curing Compound:** ASTM C 309, Type 1, Class B, 18 to 22 percent solids.

H. **Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound:** ASTM C 1315, Type 1, Class A.

I. **Clear, Waterborne, Membrane-Forming Curing and Sealing Compound:** ASTM C 1315, Type 1, Class A.

2.10 RELATED MATERIALS

A. **Joint-Filler Strips:** ASTM D 1751, asphalt-saturated cellulosic fiber.

B. **Joint-Filler Strips:** ASTM D 1752, cork or self-expanding cork.

C. **Joint-Filler Strips:** ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

D. **Epoxy Joint Filler:** Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.

E. **Bonding Agent:** ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

F. **Epoxy-Bonding Adhesive:** ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:

1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.

2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

G. **Reglets:** Fabricate reglets of not less than 0.55 mm thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

H. **Dovetail Anchor Slots:** Hot-dip galvanized steel sheet, not less than 0.85 mm thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.11 REPAIR MATERIALS

A. **Repair Underlayment:** Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 3 mm and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 3 to 6 mm or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 30 MPa at 28 days when tested according to ASTM C 109M.

B. **Repair Topping:** Traffic-bearing, cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 6 mm.

1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 3 to 6 mm or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 40 MPa at 28 days when tested according to ASTM C 109M.

2.12 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:

1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
2. Proportion lightweight structural concrete according to ACI 211.2 and ACI 301.

B. Use a qualified independent testing agency acceptable to the Engineer for preparing and reporting proposed mix designs for the laboratory trial mix basis.

1. Do not use the same testing agency for field quality control.

C. Submit written reports to the Engineer of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed and approved by the Engineer.

D. Design mixes to provide normal-weight concrete with the following properties unless otherwise indicated on Drawings:

1. Blinding Concrete: Proportion normal-weight concrete mix as follows:
   a. Compressive Strength (28 Days): 14 MPa.
   b. Maximum: water cement ratio:0.55.
2. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:

a. Compressive Strength (28 Days): 40 MPa.

b. Maximum water cement ration: 0.4

3. Slab-on-Grade: Proportion normal-weight concrete mix as follows:

a. Compressive Strength (28 Days): 30 MPa.

b. Maximum water cement ratio:0.40

4. Light-weight concrete for topping steel deck: Proportion light-weight concrete mix with maximum specific gravity (1800 kg/cu.m) as follows:

a. Compressive Strength (28 Days): 30 MPa.

b. Maximum water cement ratio: 0.4

c. Minimum cement content: 350 kg/cu.m.

E. Cement Content:

1. Structural concrete shall contain a minimum of 355 kg/cu. m of Ordinary Portland Cement (OPC) plus silica frame if needed. All concrete below ground shall have protective coating as specified.

2. Blinding/mudmat concrete shall contain sufficient OPC to obtain the specified design strength.

F. **Water-Cement Ratio:** The free water-cement ratio shall not exceed 0.40. The water-cement ratio shall be the water content divided by the cement. The water-cement ratio shall be continuously checked at the mixer with due allowance made for water contained in the aggregates. Under no circumstance shall water be added between the mixer and the place of concrete placement. The Engineer may require that the water-cement ratio be checked during tests performed on fresh concrete samples taken at the time of placement as specified.

G. **Slump Limits:** The slump of concrete mixes shall be such that the concrete can be transported, placed into the forms, and compacted without segregation in accordance with Article 3.8. If no superplasticizer is required, the slump at time of placement shall be 50-75 mm as measured in accordance with ASTM C 143.

H. Total Salt Content:

1. Chlorides: The total chloride content (sum of both acid soluble and water soluble chlorides) of the concrete from all sources, expressed as chloride ion, shall not exceed 0.15 percent by weight of dry cement, when tested in accordance with BS 1881.

2. Sulfates: The total sulfate content of the concrete from all sources, expressed as SO3, when tested in accordance with BS 1881, shall not exceed 3 percent by weight of dry cement.

I. Initial Setting Time:

1. The initial setting time shall be not less than one hour after the production concrete is discharged into the form. With a maximum time between mixing and placing concrete of one hour, the total time between mixing and initial set shall be a minimum of 2 hours. There shall be a maximum setting time of 6 hours.

2. When trial mixes are made to determine the workability of the concrete, the initial setting time of the cement paste shall be determined using the method defined in ASTM C 191 but at the maximum allowable temperature and with same proportions of retarding superplasticizer as specified in this Specification.

J. **Test Mixes - Structural Concrete Grades:** When the proposed workability, proportions of aggregates and superplasticizer, and strength for each grade of concrete have been established, concrete mixes shall be produced for testing. The results shall be submitted for approval by the Engineer. The following shall be performed for each grade of concrete:

1. Six separate trial test mixes shall be made. Samples consisting of six cylinders for each mix to be cured in accordance with ASTM C 192 and tested in accordance with ASTM C 39.

2. The 36 cylinders for each grade of concrete shall be tested for compressive strength at 28 days and the mean strength and standard deviation established for each grade.

3. The acceptance criteria for test mixes shall be as follows:

   a. The mix proportions and workability are in accordance with this Specification.

   b. The standard deviation for each grade is 3.5 MPa or less.

   c. The mean strength for structural concrete exceeds the specified design strength by 6 MPa.

K. Test Mixes - Blinding or Mudmat Concrete:

1. Concrete for blinding or mudmat shall be a designed mix with the specified design strength of 14 MPa. The trial mix proportions shall be left to the discretion of the Contractor. Once they have been chosen, three separate test mixes shall be made with those proportions and three 150 mm test cylinders shall be made from each mix for testing at 28 days. The trial mix proportions and water/cement ratio shall be approved if the average strength of the nine cylinders is not less than the specified design strength.

2. No production test shall be made for this grade of concrete but the Engineer will monitor the mix proportions and water/cement ratio.

L. **Adjustment to Concrete Mixes:** Mix design adjustments may be requested when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised mix design and strength results shall be submitted to and approved by the Engineer before using in the Work.

M. **Absorption Test:** The absorption of the hardened concrete from the trial mixes for structural grades shall be tested as a measure of the concrete's ability to resist the ingress of aggressive salts. No absorption tests shall be required for blinding or mudmat concrete. Absorption tests shall be in accordance with modified BS 1881: Part 122 as follows:

1. After trial mixes have been accepted, three 150 mm cylinders shall be cast from each grade of concrete and immersed in water at 20 deg. C for 7 days.

2. At the end of the curing period, 75 mm diameter core specimens shall be cut along the longitudinal axis of each cylinder to a depth of 75 mm.

3. The specimens shall be dried in an oven at 105 deg. C for 72 hours.

4. The specimens shall be cooled in a dry airtight vessel for 24 hours, weighed, and than immediately immersed in a tank containing water at 20 deg. C with the longitudinal axis of the cores horizontal, and with 25 mm depth of water

over the specimens.

5. The specimens shall be immersed for 24 hours, then removed, shaken, surface dried, and reweighed. The water absorption shall be calculated as the increase in mass resulting from immersion, expressed as a percentage of the dry mass.

6. If the cores lengths differ from 75 mm, a correction factor (graph given in BS 1881) shall be applied.

7. The mean of the corrected absorption figure for each concrete grade shall be calculated and the absorption of the concrete mixes shall be acceptable if the mean absorption is less than 2 percent at 30 minutes. The mean absorption figure and the lowest absorption figure shall be recorded for each grade and used for comparison purposes with absorption tests carried out on cores cut from in-situ concrete, as scheduled in Paragraph 3.21 .C.4.

N. Test Construction:

1. Test Foundation: A test foundation footing and plinth shall be cast on grade to the details provided by the Engineer in accordance with specified requirements. This shall be performed before any permanent works are constructed. The concrete shall be cured for the period required in Article 3.13, after which an epoxy coating shall be applied to that part of the plinth which would normally be above ground and a bitumen coating applied to the remainder of the plinth and the footing, all in accordance with Article 3.17.

2. Test Floor Slab: A 3 m by 4 m test area of 150 mm thick floor slab constructed of above ground reinforced concrete in accordance with this Specification shall be cast on grade and given a Class U4 finish as specified in Paragraph 3.11.E. The concrete shall be cured for the period specified in Article 3.13.

O. **Cementitious Materials:** Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:

1. Silica fume: 5%

P. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

Q. **Admixtures:** Use admixtures according to the manufacturer's written instructions.

1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

A. All to be as required and approved by the Engineer, for placement and workability. Use admixtures in accordance with the manufacturer's instructions. Ensure that the correct quantity of admixture is used at all times. The equipment to be used for dispensing and the method of incorporating the admixture into the concrete shall be subject to approval. The dispensing unit shall be translucent so that the operator can see the discharge of the admixture.

2.13 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

A. **General**: Concrete production shall be in accordance with ACI 304. A checklist for concrete production shall be produced, such as that used by the NRMCA or approved equal.

1. Batching of materials shall be by weight. All weighing equipment shall be calibrated and documentation shall be provided to establish that the accuracy is continuously maintained in accordance with the requirements of ACI 304. Batching scale accuracy shall be in accordance with the Concrete Plant Standards of the Concrete Plant Manufacturers Bureau, or approved equal.

2. Furnish the necessary equipment and establish accurate procedures for determining the quantities of free moisture in the aggregates. Moisture determinations shall be made daily and whenever there is an apparent change in the moisture content. The moisture content shall be recorded. The moisture of aggregates shall be utilized in adjusting the weight of aggregate added to the mix. The water added to the mix shall be similarly adjusted.

B. **Job-Site Mixing:** All concrete mixed on Project site shall be in a batch mixer of approved size and design complying with ACI 304 and producing a uniform distribution of the materials throughout the mixed concrete in accordance with ASTM C 94 uniformity test. The contents of the drum shall be completely discharged before re-charging. After all the materials are in the mixer, mixing shall continue until the whole of the materials are uniformly distributed and the mass is of uniform color and consistency. In the case of concrete that contains silica fume with a density between 400-650 kg/cu. m, the mixing time shall be 50 percent greater than the requirement for concrete without silica fume.

1. Whenever mixing is to be suspended for half an hour or longer, the drum of the mixer shall be thoroughly washed out with clean water. Provide a competent operator who shall be in continuous control of the mixer. No retempering of concrete, which has partially hardened, by the addition of cement, aggregate, or water shall be allowed.

2. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

C. Ready-Mixed Concrete:

1. Ready-Mixed concrete shall comply with the requirements of ASTM C 94 or BS 5328 and as follows:

   a. Concrete shall be centrally mixed off site and transported in an agitator truck. Truck mixing shall not be permitted.

   b. The plant and trucks shall be certified as meeting the requirements of the NRMCA Check List, or approved equal.

   c. Details and information regarding the supplier proposed by the contractor shall be submitted to the Engineer for approval.

   d. The sewer of ready mixed concrete shall not subsequently be charged without further approval of the Engineer.

2. When air temperature is between 30 deg.C and 32 deg.C, delivery time from the time water is added to the mix until it is placed in its final position in the form shall not exceed 60 minutes. When air temperature is above 32 deg.C, delivery time shall not exceed 45 minutes.

3. Before discharging concrete at the point of delivery, provide the Engineer with a delivery ticket for each batch of concrete containing the following information as a minimum:

   a. Name or number of off-site concrete depot.

   b. Serial number for ticket.

   c. Date.

   d. Time of dispatch.

   e. Truck number.

   f. Name of Supplier.

   g. Grade or mix description of concrete.

   h. Type of cement.

   i. Cement content.

   j. Water/cement ratio.

   k. Nominal maximum size of aggregate.

   l. Source of aggregate, maximum size, weight of fine and coarse aggregate.

   m. Type or name of admixture, if included.

   n. Quantity of concrete in cubic meters.

   o. Certifying that chlorides and sulfate contents are within specified limits and stating their values.

   p. Amount of concrete in cubic meter

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads. Design of formwork shall be the sole responsibility of the Contractor.

B. Construct formwork so that concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

   1. Class A, 4 mm.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

1. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of concrete receiving applied waterproofing membranes.

I. Do not chamfer corners or edges of concrete unless otherwise indicated.

J. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

M. Coat contact surfaces of forms with form release agent, according to the manufacturer's written instructions, before placing reinforcement.

N. Where it is required to use internal ties and spacers, their type, spacing and use shall be to the, approved of the Engineer. In no circumstances shall these ties protrude out of the finished concrete, all ties must be cut back into the structural concrete and the surface made good to satisfy the requirements of the minimum spacing and cover.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor bolts, accurately located, to elevations required.

2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. **General:** Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 10 deg.C for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. The Engineer shall be notified when the Contractor intends to remove any formwork at least 6 hours prior to starting the process.

C. Leave formwork, for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved the following:

1. 28-day design compressive strength.

2. At least 70 percent of 28-day design compressive strength.

3. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.

4. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

D. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form release agent.

E. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Engineer.

3.4 SHORES AND RESHORES

A. Comply with ACI 318M, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.

B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

A. **Vapor Retarder:** Place, protect, and repair vapor retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

B. **General:** Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.

C. Lap joints 150 mm and seal with manufacturer's recommended mastic or pressure-sensitive tape. Cover vapor retarder/barrier with sand cushion and compact to depth indicated.

3.6 STEEL REINFORCEMENT

A. **General:** Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Avoid cutting or puncturing vapor retarder/barrier and waterproofing membranes during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.

C. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

D. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh

spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

E. Shipping and Storage:

1. Reinforcement shall be handled and shipped in a manner to avoid bending or other damage to the bars. Bars shall be bundled, separated in sizes and clearly marked by diameter size preferably for one placement, in accordance with the placement schedule and as follows:

    a. Bars for separate buildings or large structures shall not be bundled together. Bars for small structures may be bundled together but each bar or group of bars that have the same piece mark shall be tagged and coded.

    b. Metal tags or approved equal shall be provided and labeled with legible markings.

    c. All bundles shall be tagged at each end. Tags shall show piece marks corresponding to the mark numbers on the placement drawings and on the bar list.

    d. Bars shall be bundled in the largest size practical for handling and shipping.

2. Reinforcement shall be stored 1m above ground on platforms, skids or other approved supports and suitably spaced. Contact with the soil shall be avoided. Proper drainage and protection from the elements shall be provided to minimize corrosion.

F. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

G. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement on concrete blocks of a size to give the correct cover to the reinforcement. Concrete spacer blocks shall be made of the same materials, to the same specified requirements and have the same inherent properties as the parent material, but with the exception that the maximum aggregate size shall be appropriate for the thickness of cover to the reinforcement.

1. Chairs made of reinforcement shall be used to support the top mats of slab reinforcement and they shall be so dimensioned as to be stable during concreting operations. The chairs shall themselves be supported on concrete blocks as specified above.

H. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Ties at intersections shall be made with 1.5 mm diameter annealed wire with wire ends directed into concrete, not toward exposed concrete surfaces.

I. Concrete Cover:

1. Concrete cover to reinforcement shall be as indicated on Drawings but shall not be less than the following:

    a. Cover for all concrete below grade and waterproofed shall be 50 mm.

    b. Cover for all other exterior exposed concrete faces shall be 50 mm.

    c. Cover for all other interior protected faces shall be 40 mm, except slabs which shall be 25 mm.

2. Cover to reinforcement shall be checked before any concrete is cast. The bending of reinforcement at a cold joint is not permitted. Concrete cover shall be checked with a cover meter as soon as formwork is removed.

J. All lap splices shall be in accordance with ACI 318 class B tension lap splice unless otherwise shown on Drawings. All reinforcement bars shall be developed in accordance with ACI 318 unless otherwise shown on Drawings. Welded wire fabric shall be lapped 1.5 mesh plus the extension on the wires unless otherwise shown on Drawings.

3.7 JOINTS

A. **General:** Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints:

1. Locate and install construction joints so that they do not impair strength or appearance of the structure, and are acceptable to the Engineer. Unless otherwise shown or approved, provide and locate construction joints in accordance with ACI 301. Where construction joints are indicated in construction documents, no deviation shall be allowed without the approval of the Engineer. Additional joints shall be kept to a minimum and must be approved by the Engineer. The joint surface shall be roughened to remove laitance without disturbing the coarse aggregate by pressure jetting with air and water or by wire brushing. The joint shall be clean prior to placing fresh concrete. The new concrete shall be well worked against the old concrete to ensure a good joint.
2. The use of expanded metal or other perforated material is prohibited in construction joints.
3. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders.
6. Space vertical joints in walls as indicated, or as required by the Engineer.
7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Waterstops: Provide waterstops in construction joints. Install waterstops to form a continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to the manufacturer's printed instructions.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 3 mm. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 3 mm wide joints into

concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface.

2. Terminate full-width joint-filler strips not less than 12 mm or more than 25 mm below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.

3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.

1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

F. Score Joints for Landscape Concrete Paving: As shown on Drawings.

G. Unless otherwise indicated on design drawings, joint sealing shall be in accordance with ACI 504R.

3.8 WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

A. **General:** Comply with ACI 301, ACI 304, and ACI 318.

B. **Inspection:** Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work. Concrete shall not be placed until the condition of the reinforcement, other embedded items, and the formwork has been inspected and approved by the Engineer.

C. **Transportation:** Concrete, after being discharged from the mixer, shall be transported as rapidly as possible to its final position in the Work by agitator trucks, which shall prevent adulteration, segregation, loss of workability or contamination of the ingredients. The containers that convey the concrete shall be kept clean and free from hardened or partially hardened concrete.

1. The addition of water at the point of discharge is prohibited and trucks shall have the water tank completely disconnected from the drum.

2. The use of chutes, spouts, skips and pumps shall be permitted if approval is obtained. Under no circumstances shall any aluminum pipe or other conveying equipment containing aluminum be allowed to contact fresh concrete when it is conveyed to its point of placement.

3. Method of pouring and pouring sequence shall be submitted by the Contractor to the Engineer’s approval.

D. **Placing Concrete in Forms:** Deposit concrete in forms continuously or in horizontal layers no deeper than 450 mm and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while the preceding layer is still plastic to avoid cold joints. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

1. Concrete shall not be dropped into place from a height exceeding 1.5 m nor through dense reinforcing steel, which could cause segregation of the coarse aggregate. Structural concreting against open excavation will not be permitted as the concrete cannot be coated afterwards.

2. When vertical lifts of concrete are interrupted or delayed for more than one hour, the surface of the unfinished concrete shall be thoroughly cleaned and washed with cement grout immediately before fresh concrete is added and the first layer of new concrete placed shall not exceed 150mm depth and particular care shall be taken with compaction of this new layer to ensure good bond.

3. Method of pouring and pouring sequence shall be submitted by the Contractor to the Engineer's approval.

E. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by the Engineer.

F. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

G. Deposit concrete in forms in horizontal layers no deeper than 600 mm and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.

1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 150 mm into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

H. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Maintain reinforcement in position on chairs during concrete placement.

3. Screed slab surfaces with a straightedge and strike off to correct elevations.

4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

I. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 5 deg.C, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 10 deg.C and not more than 27 deg.C at point of placement.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

J. **Compaction and Vibration:** Full compaction of the concrete shall be achieved throughout the entire depth of the layer. It shall be thoroughly worked against the formwork and around the reinforcement and successive layers shall be thoroughly bonded together. Air bubbles formed during the mixing and casting shall be expelled particular care shall be taken where sloping formwork is used.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 150 mm into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, avoid over vibration and limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

K. **Placing Concrete Slabs:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations. Maintain reinforcing in proper position during concrete placement.

L. **Hot-Weather Placement:** When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 25 deg.C. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is the Contractor's option.

2. Concrete temperature shall not exceed 32 deg. C and the temperature

differential shall not exceed 25 deg. C.

3. No concreting operation shall be carried out at ambient temperature of 40 deg. C or more.
4. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
5. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
6. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to the Engineer.
7. Shade mixing plant and trucks, aggregates, water tank, and cement silo.
8. Paint white the mixing plant, trucks, water tank, and cement silo.
9. Insulate the water tank and supply piping.
10. Provide necessary shades over and around the concrete being poured to prevent sun rays from coming into direct contact with the surface of the concrete and the formwork for a period of about 7 days (minimum from the time of pouring concrete).
11. Concrete placing shall be completed as quickly as possible to reduce transit time.
12. Curing of exported concrete shall be immediately carried out.

3.10 FINISHING FORMED SURFACES

A. **Rough-Formed Finish (Class F1):** Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. Concrete surface texture is that imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 7 mm in height rubbed down or chipped off. This finish class is not applicable to elements where backfill is to be placed against the concrete.

B. **Smooth-Formed Finish (Class F2):** Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, such as waterproofing, damp-proofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed. No ledges shall be permitted at the position of joints in the formwork.

C. **Smooth-Rubbed Finish (Class F3):** Provide smooth-rubbed finish not later than 1 day after form removal on scheduled concrete surfaces that have received smooth-formed finish treatment. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. **Grout-Cleaned Finish (Class F4):** Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.

1. Combine one part Portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement in amounts determined by trial

patches so that final color of dry grout shall match adjacent surfaces.

2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. **Cork-Floated Finish:** Wet concrete surfaces and apply a stiff grout. Mix one part Portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

F. **Related Unformed Surfaces:** At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. **General:** Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. **Scratch Finish (U1):** Apply scratch finish to monolithic slab surfaces receiving concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured in accordance with ASTM E 1155M. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

C. **Nonslip Broom Finish (U2):** Apply a nonslip broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom

perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

D. **Float Finish (U3):** Apply float finish to monolithic slab surfaces receiving trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured in accordance with ASTM E 1155M. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

E. **Trowel Finish (U4):** Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film finish coating system. This finish is also applicable to tops of buried foundations since they have to be subsequently coated.

1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is

moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances in accordance with ASTM E1155M of the following:

a. Specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15.

b. Specified overall values of flatness, F(F) 35; and levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17; for slabs-on-grade.

c. Specified overall values of flatness, F(F) 30; and levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and levelness, F(L) 15; for suspended slabs.

d. Specified overall values of flatness, F(F) 45; and levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and levelness, F(L) 24.

2. Grind smooth any surface defects that would telegraph through applied floor covering system.

3. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 3 m long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:

a. 7 mm.

b. 5 mm.

c. 3 mm.

F. **Trowel and Fine Broom Finish (U5):** Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

G. **Colored Wear-Resistant Finish (U6):** Apply a colored wear-resistant finish to monolithic slab surface indicated.

1. Apply dry shake materials for the colored wear-resistant finish at a rate of 5 kg/sq. m, unless a greater amount is recommended by material manufacturer.

2. Cast a trial slab approximately 3 m square to determine actual application rate, color, and finish, as acceptable to the Engineer.

3. Following placement, vibrating and leveling, float the concrete with a wooden float to “open” the surface and allow the excess moisture and air to escape.

4. Once the sheen has disappeared, apply floor hardener as a dry shake onto the wet surface. Apply approximately one-half of the material and then float into the surface with a wooden float.

5. Following the first float, apply the balance of the material and float in the same fashion.

6. Once the surface is firm enough to take foot traffic, use a power float to finish the surface to a smooth and non-slip finish.

7. After floating, apply a trowel finish as specified. Cure slab surface with a curing compound recommended by the dry shake material manufacturer. Apply the curing compound immediately after the final finishing.

H. **Broom Finish:** Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

I. **Slip-Resistive Aggregate Finish:** Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 12 kg/10 sq. m of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.

2. After broadcasting and tamping, apply float finish.

3. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. **Filling In:** Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.

B. **Curbs:** Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. **Equipment Bases and Foundations:** Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. **Steel Pan Stairs:** Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

E. Tolerance and concrete dimensions for in-situ concrete members shall, under no circumstances, exceed the permissible ones as indicated in the ACI.

3.13 CONCRETE PROTECTION AND CURING

A. **General:** Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.

B. **Evaporation Retarder:** Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 1 kg/sq. m x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. **Formed Surfaces:** Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:

D. **Unformed Surfaces:** Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 300 mm lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 300 mm, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.

E. **Curing Methods:** Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified below.

1. Horizontal Surfaces: Horizontal surfaces shall be saturated with water and then treated with curing compound. Apply curing compound as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. The surfaces shall then be bonded and flooded with water or draped with wet burlap together with a perforated soaker hosepipe, covered with white impervious sheeting held firmly in place along all edges and kept continuously wet for the duration of the curing period.

2. Vertical Surfaces: Vertical timber formwork shall be draped with wet burlap as soon as concrete is placed. Vertical surfaces shall be treated with curing compound as soon as formwork is removed, draped with wet burlap, covered with white impervious sheeting held firmly in place along all edges and kept continuously wet for the duration of the curing period. Care shall be taken to avoid drying winds.

3. Impervious Sheeting: Impervious sheeting shall be in accordance with ASTM C 171.

3.14 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semi-rigid epoxy joint filler full depth in saw-cut joints and at least 50 mm deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

A. Concrete exposed by the removal of formwork shall be inspected by the Engineer before any remedial work, subsequent coating or other treatment that would hinder the proper inspection of the concrete is carried out. Any concrete not complying with this requirement shall be liable for rejection.

B. Concrete not meeting the specified requirements shall be removed and rebuilt without delay unless the Engineer approves that a repair may be satisfactorily effected. This agreement shall not preclude the subsequent rejection of the repaired work by the Engineer. The proposed method for removal and replacement of defective work shall be submitted to the Engineer for approval for each concrete placement before the removal commences.

C. All repairs approved by the Engineer shall be performed by a subcontractor specialized in the repair of concrete in the Middle East and prepared to guarantee the work. Any repair method submitted for approval shall produce a result that is as impermeable as the original concrete. Subsequent tests on the repaired concrete shall be carried out at the discretion of the Engineer in order to establish the quality of the repair, particularly at the joint between the original and the repaired concrete.

D. **Defective Concrete:** Repair and patch defective areas when approved by the Engineer. Remove and replace concrete that cannot be repaired and patched to the Engineer's approval.

E. **Patching Mortar:** Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a 1.2 mm sieve, using only enough water for handling and placing.

F. **Repairing Formed Surfaces:** Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 13 mm in any dimension in solid concrete but not less than 25 mm in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Engineer.

G. **Repairing Unformed Surfaces:** Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.25 mm wide or that penetrate to reinforcement or completely through un-reinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 6 mm to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 25 mm or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 20 mm clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 25 mm or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

H. Perform structural repairs of concrete, subject to the Engineer's approval, using epoxy adhesive and patching mortar.

I. Repair materials and installation not specified above may be used, subject to the Engineer's approval.

3.16 CONCRETE PROTECTION - RAFT, FOUNDATION, WALLS, COLUMN NECKS AND OTHER BURIED STRUCTURES

A. All foundations, rafts, pile caps, strap and tie beams, column necks, etc., in contact with the soil or binding shall be protected by one layer of non-reinforced SBS (20%) modified membrane as specified below.

B. The blinding and concrete surfaces to which the membrane is to be applied shall be clean, smooth, dry, free of fins, sharp edges, loose and foreign materials, oil and grease.

C. All imperfections, depressions, hollows, etc shall be made good and prepared to receive the tanking/water proofing membrane.

D. Cement sand fillet 50 x 50 mm shall be provided at all internal corners and all external corners shall be chamfered to provide smooth transition.

E. The shoring system wall shall be shotcreted and if need be plastered to obtain an even, smooth surface for the application of tanking as recommended by the applicator and as approved by the Engineer. After the shotcrete/plaster has cured and dried for at least 3 days, the surface shall be cleaned of all grease, oil, dust, loose material, etc and shall present a sound and smooth surface in one straight plane, free of any sharp protrusions or depressions and any extraneous matter.

F. The horizontal membranes shall be protected by a layer of slip-sheet of minimum 200 gm/m2 and a layer of cement sand screed of minimum 30 mm thickness against damage from reinforcement and site traffic. The area of the membrane laid at any one time should not exceed that which can be protected by screed in the same period. Care should be exercised in the sequence of laying screed to ensure that the membrane laid is damaged due to site traffic or other trade works or any other cause.

G. The membrane laid vertically shall be protected by a continuous wall of extruded polystyrene boards 25 mm thick spot bonded all along the edges and the centre of the boards to the membrane as recommended by the manufacture and/or as directed by the Engineer to prevent any damages from wall reinforcements and formwork.

H. Extreme care shall be taken not to damage the membrane during the erection of reinforcement steel and shuttering for wall. The area of the membrane/polystyrene that is outside the limits of concrete shall be protected as approved by the Engineer.

I. A layer of 3 mm thick sand cement screed for horizontal layers and a layer of Protection board for vertical layers shall be used to protect the membrane from damage against back filling for all foundation members other than the basement walls (which shall be protected as detailed above).

J. The priming of the surfaces, the laying of the membrane, laps and joining of the membrane and application shall be as per the recommendations of the manufacturer and to the approval of the Engineer.

K. The treatment/termination of the membrane at the top most position above ground level shall be as recommended by the applicator and subject to the approval of the Engineer.

L. Alternative waterproofing systems may be submitted to the Engineer for review and approval. Submittal shall include technical data and case histories sufficient for the Engineer to do a technical evaluation of the proposed systems.

M. Install membrane system in accordance with the membrane manufacturer's instructions.

N. Submit the following to the Engineer for approval before beginning the work:

1. List of all membrane materials, joint compounds, and concrete surfaces to be used in the Work. List shall identify the specific products by manufacturer and catalog number.

2. Procedures for material storage and handling, surface preparation, environmental control, application sequence, overlap dimensions, touch-up and repair, curing, and inspection of the membrane system. The membrane manufacturer’s published instructions and installation details shall be attached as part of submitted procedures. Conflicts between the material manufacturer's recommendations and Contract Documents shall be noted in writing to the Engineer for resolution.

3. Cleaning and installation verification forms for daily inspection records. A detailed cleaning and installation verification report in accepted form shall be completed each day during the work and submitted for record. The final verification report shall include a statement of completion conformance verifying that the required materials were used and that the accepted application procedures and specified requirements were followed.

4. Details concerning corners, bottom slab to wall tie-ins, slab/wall/roof penetrations, terminations, control joints, expansion joint, and crack control.

5. Manufacturer material safety data sheets for all materials used in the execution of the work.

O. Arrange for the material manufacturer's technical representative to be present at the beginning of work and to qualify installation personnel in the installation of the manufacturer's waterproofing products.

P. **Joints:** Unless otherwise shown on design drawings, joints shall be designed and constructed in accordance with ACI 504R. Details and positioning of joints, together with the materials to be used, shall be submitted for the Engineer's approval.

1. Waterstops shall be in accordance with Paragraph 2.8A. Jointing of waterstops shall be made by welding in an approved fashion. Lapping of waterstops at joints and the use of adhesives for jointing purposes will not be permitted unless approved by the Engineer. Waterstops shall not be perforated or damaged. Concrete shall be carefully placed and compacted to ensure dense impervious concrete, particularly around the ribs of waterstops. At all joints except for expansion joints as indicated on Drawings, the concrete shall be placed up to the centerline of the waterstop. All starters to walls of watertight construction shall be cast using hung formwork so that the concrete in the starters is placed simultaneously with the concrete in the slab.

3.17 GROUTING

A. **Preparation:** Concrete foundation top shall be cleaned of dirt, laitance, oil and grease. Anchor bolt boxes and sleeves shall be cleaned of all polystyrene and other deleterious material. The surface of the concrete shall be thoroughly wetted just prior to grouting but shall contain no excess water, particularly in the bolt boxes and sleeves.

B. Materials:

1. Type G1: For interior bases protected from weather and saline bearing waters and not subject to heavy or vibratory loads, grout shall consist of one part Portland cement to two parts well graded sand by volume. Sand shall comply with Paragraph 2.5.C.2.A retarding superplasticizer may be used if necessary to obtain the correct fluidity in high ambient temperatures.

2. Type G2: For all heavily loaded structural column bases and equipment bases subjected to vibratory loads, a proprietary non-shrink, non-metallic high strength grout especially formulated for high-temperature work.

3. Type G3: For all other exterior work exposed to potential saline ingress, a proprietary general purpose non-shrink grout, especially formulated for high temperature work.

C. Placement:

1. The manufacturer's recommendations shall be followed for proprietary grouts. The temperature of the grout at time of placement shall not exceed 25 deg.C (77 deg. F) and the temperature of the elements in contact with the grout shall not exceed 40 deg.C (104 deg. F) . To obtain the required temperatures, it may be necessary to do the following:

   a. Shield the materials from the direct rays of the sun.

b. Mix materials with flaked ice.

c. Cool base plates with water but ensure that anchor bolt pockets are free from water.

d. Require certification of plant and trucks to meet requirements of the NRMCA Check List or approved equal.

2. Grout strength shall not be less than 30 N/sq.mm at 28 days. Document to Engineer that this strength is being achieved. Grouting shall not proceed until the steel work or equipment has been leveled and plumbed with the bases being supported in the meantime by steel packers and shims.

3. Completely fill anchor bolt sleeves with grout before placing grout under base plates. The gravity grouting method shall be used wherein the flowable self-leveling grout is poured on one side of a base until it flows out at the opposite side. Packers and shims used to level bases shall be removed after the grout has set and the resulting pocket repaired with similar grout.

3.18 WATER-RETAINING CONSTRUCTION

A. **General:** Water-retaining construction shall comply with this Specification.

B. **Joints:** Joints shall be designed and constructed in accordance with ACI 504R. Details and positioning of joints, together with the materials to be used, shall be shown on the Drawings.

1. Waterstops shall be in accordance with Paragraph 2.6.A. Jointing of waterstops shall be made by welding in an approved fashion. Lapping of waterstops at joints and the use of adhesives for jointing purposes shall not

be permitted unless specifically authorized. Waterstops shall not be perforated or damaged. Concrete shall be carefully placed and compacted to ensure dense impervious concrete, particularly around the ribs of waterstops. At all joints the concrete shall be placed up to the centerline of the waterstop. All starters to walls of watertight construction shall be cast using hung formwork so that the concrete in the starters is placed simultaneously with the concrete in the slab.

C. **Coating:** Coat inside faces of structures containing waters with protective coating as per section 07162.

D. **Testing:** In addition to the testing required in Paragraph 3.19.C, further tests to determine the watertightness of the structure shall be performed in accordance with BS 8007. The structure shall be filled with fresh water to the designed level and after a period to allow for absorption of water, the faces remote from the liquid shall be inspected for leaks over a 7-day period. Any defects shall be repaired by an approved method, which could involve demolition and rebuilding, or lining of the structure.

3.19 QUALITY CONTROL AND TESTING

A. General:

1. Testing Laboratory:

a. Employ an independent testing agency to perform tests and to submit test reports.

b. Be responsible for taking, identifying and delivering to the test laboratory all test samples called for in this Specification. The testing

laboratory shall be responsible for the testing. Collect all test results and deliver them to the Engineer in the format and detail as specified.

2. Testing Laboratory Qualifications: The testing laboratory shall be accredited by NAMAS or an equivalent National Standard and shall have a Quality System in accordance with ANSI Q9001.

B. **Quality Control - Testing on Fresh Concrete:** Compressive Strength Test for Structural Concrete:

a. Sampling, curing and testing shall be performed using the relevant procedures in ASTM C 31, ASTM C 39, and ASTM C 172.

1) Samples for production of concrete cylinders shall be taken at the point of placement at the average rate of one per 25 cu. m of concrete placed, with a minimum of one sample taken every day that the mix is used. A sample shall consist of six 150 mm cylinders molded and stored for laboratory-cured test specimens except when field-cured test specimens are required. Three cylinders are for testing at 7 days after casting, three for testing at 28 days after casting.

2) If frequency of testing provides fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

3) When total quantity of a given class of concrete is less than 25 cu. m, the Engineer may waive strength testing if adequate evidence of satisfactory strength is provided.

4) When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

b. Records: Records shall be kept of the mix details and position in the works of all batches of concrete and of all samples taken for cylinders and other specimens and of their test results. A copy shall be supplied to the Engineer within 24 hours after recording/testing. Records shall contain, but not be limited to, the following information:

1) Date, time, location, and volume of pour.
2) Ambient temperature and humidity.
3) Concrete temperature (at time of placement).
4) Cement type and manufacture.
5) Concrete type and class.
6) Aggregate type and source.
7) Admixture details.
8) Water/cement ratio.
9) Identification of test cylinder.
10) Name of concrete testing service.
11) Date and time of sampling.
12) Method of compaction.

13) Date of testing and results of test.

14) Age of sample in days, weight in grams, density in kg/cu. m.

15) Crushing load in newtons and crushing strength in N/sq. mm.

16) Signatures of person preparing cylinder and of person crushing cylinder.

17) Results of testing.

c. For the 28-day tests, the concrete will be deemed to comply with the specified design strength if the average strength determined from all sets of 3 consecutive tests is at least equal to the specified design strength and no individual strength test falls below the specified design strength by more than 3.5 N/sq. mm. Any concrete not complying with the specified design strength shall be at risk for removal and replacement at the Contractor's expense.

d. The 28-day cylinder crushing results shall be grouped consecutively in groups of 40 and each group shall have a standard deviation less than 3.5 N/sq. mm. If the standard deviation is greater than or equal to 3.5 N/sq. mm, then concrete production shall be investigated by the Engineer and further tests on trial mixes may be required.

e. Tests shall be carried out at 7 days to establish a relationship between the 7-day and 28-day strengths. This relationship shall be used to interpret future test results in order to predict the corresponding 28-day strength. The Engineer shall be advised without delay of any 7-day test result indicating that the corresponding 28-day strength will likely fail to meet the specified strength so that any necessary action can be taken to minimize the effect of such possible failure.

2. Compressive Strength Test for Blinding or Mudmat Concrete: There shall be no production tests on blinding or mudmat concrete. The Engineer will require compressive strength tests if it is believed that the characteristic strength is below 10 N/sq. mm. Characteristic strength is defined as that value of the cube strength below which 5 percent of all possible test results would be expected to fall. If the tests confirm that the characteristic strength is less than 10 N/sq. mm, then the Engineer will require revisions to the mix design to ensure that the concrete meets the specified requirements.

3. Measurement of Concrete Temperature: Temperature measurements shall be in accordance with ASTM C 1064. Concrete temperature shall be measured 50 mm below the surface prior to and at the point of placement and recorded on the pour card for each pour. There shall be one test hourly when air temperature is 4 deg.C and below and when air temperature is 27 deg.C and above, and one test for each set of compressive-strength specimens. Concreting shall stop if the temperature of the concrete does not meet the requirements of Paragraph 3.9.L

4. Cement Content and Water/Cement Ratio: Samples of freshly mixed concrete shall be chosen by the Engineer at least once per month from each structural grade and determination made of cement content and water/cement ratio in accordance with BS 1881. If the cement content is less than 90 percent of the requirement in Paragraph 2.12 or the water/cement ratio greater than 110 percent of the requirement in Paragraph 2.12 then there shall be an investigation to establish the cause and the Engineer may reject the casted concrete for the pour from which the samples were taken. The Engineer may request an analysis of fresh concrete from any pour. No analysis of freshly mixed concrete is required for blinding or mudmat concrete.

5. Salt Content: The total concentration of sulfates and chlorides in fresh concrete shall be measured at least once a week for all structural grades of concrete. Tests shall be in accordance with BS 1881. Concentrations of each ion shall not exceed the limits specified in Paragraph 2.12. If these limits are exceeded, the concrete pour from which the samples were taken shall be rejected and further tests performed on the casted concrete in accordance with Paragraph 3.19.C to determine the total extent of the problem.

6. Slump: Slump tests shall be performed in accordance with ASTM C 143. There shall be a minimum of one test at the point of discharge for each day's pour for each type of concrete. Additional tests shall be performed when concrete consistency appears to have changed

C. **Quality Control - Testing on Hardened Concrete:**

1. General: The Engineer may request samples to be taken and tests carried out on any hardened structural grade concrete as specified below if he suspects that the concrete does not meet the specified requirements. If the tests confirm that the concrete does not meet the requirements of this Specification, then the Engineer may require the concrete to be removed at the Contractor's expense. If the tests confirm that the concrete meets the requirements of this Specification, then the cost of taking the samples shall not be at the Contractor's expense.

2. Compressive Strength Tests: The Engineer may request cores to be drilled from a particular pour. 100 mm diameter cores shall be drilled as requested, in accordance with ASTM C 42, and sent for crushing. If the cores from that pour have an average compressive strength less than 85 percent of the characteristic strength or any individual core has a compressive strength less than 75 percent of the characteristic strength, it shall be evidence that the concrete from which it was taken is not in accordance with the specified requirements.

3. Concrete Cover: The Engineer may check the concrete cover over the reinforcement with a cover meter. Any indication that the cover is generally less than the requirements specified in Paragraph 3.6 shall be checked by limited surface concrete removal. If it is confirmed that the actual cover is generally less than specified, then the concrete shall be removed at the Contractor's expense. In the case of localized lack of cover and where appearance is not important, a repair shall be effected by removal of the inadequate cover and the cutting back of concrete for 50 mm behind the reinforcement. Resurfacing of the concrete with the specified cover shall be carried out as a repair by a specialist subcontractor as specified in Article 3.16.

4. Absorption: A sample of three 75 mm diameter cores, 75 mm long, shall be taken from hardened concrete if directed by the Engineer and tested in accordance with Paragraph 2.12. Should the absorption of any core exceed by more than 1 percent the highest approved test result, then the concrete from which it was cut shall be removed. No absorption test shall be required for blinding or mudmat concrete.

5. Salt Content: Engineer may request samples to be taken from two 20 mm diameter drillings into the concrete surface, spaced 75 mm apart. Each drilling shall proceed in 25 mm increments for a total depth of 100 mm and the dust from the 4 samples in each hole shall be sent for sulfate and chloride content analysis in accordance with BS 1881. Should the tests show that the limits specified in Paragraph 2.12 are exceeded, the concrete shall be removed.

6. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be used but shall not be used as the sole basis for acceptance or rejection.

7. Additional Tests: The testing agency shall make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

SECTION 7: CONCRETE TOPPING

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract.

1.02 SUMMARY

A. This Section includes standard aggregate concrete floor toppings applied over previously placed base slabs.

1.03 SUBMITTALS

A. Furnish product data, samples laboratory test reports, and materials certificates as per Engineer instructions. Allow fourteen (14) days for Engineer review.

PART 2 -PRODUCTS

2.01 CEMENT AND AGGREGATES

A. Portland Cement: ASTM C 150, Type I.

B. Normal Weight Aggregate: ASTM C 33: Fine aggregate, consisting of sand or crushed stone screenings, clean hard, free of deleterious matter.

2.02 TOPPING MIX

A. Standard Topping: Design mix to produce topping material with the following characteristics:

1 Compressive strength: 3500 psi at 28 days.

2 Slump: 200mm maximum at point of placement for concrete containing high-range water-reducing admixture (super-plasticizer) and 75mm maximum for other concrete.

3 Maximum W/C ratio: 0.51.

2.03 MIXING

A. Provide batches type mechanical mixer for mixing topping material at Project site. Equip batch mixer with a suitable charging hopper, water storage tank, and a water-measuring device. Use only mixers that are capable of mixing aggregates, cement, and water into a uniform mix within specified time, and of discharging mix without segregation.

B. Mix each batch of 2 cu. m or less for at least 1-1/2 minutes after ingredients are in mixer. Increase mixing time 15 seconds for each additional cu. m or fraction thereof.

1. Ready-mixed topping may be used complying with requirements of ASTM C 94.

PART 3 -EXECUTION

3.01 CONDITION OF SURFACES

A. **Topping Applied to Fresh Concrete:** Do not begin placement of topping until water ceases to rise to surface, and water and laitance have been

removed from base slab surface.

1. When base slab surface is unacceptable for good bonding, roughen surface by chipping or scarifying before cleaning. Prior to placing topping mixture, thoroughly dampened slab surface but do not leave standing water. Over dampened surface apply good quality bonding compound as approved by the Architect or epoxy adhesive. Place topping mix after bonding compound has dried or epoxy adhesive is still tacky.

B. **Joints:** Mark locations of joints in base slab that joints in top course will be paced directly over them.

3.02 PLACING AND FINISHING

A. **Trowel Finish:** After floating, begin first trowel finish operation using power driven trowels. Continue troweling until surface is ready to receive final troweling, begin final troweling when a ringing sound is produced as trowel is moved over surface.

B. Continue final trowel operation to produce finished surface free of trowel marks, uniform in texture and appearance, and achieving and F/F of 25 and F/L of 20 tolerances when tested in accordance with ASTM E 1155.

C. Where joints are required, construct to match and coincided with joints in base slab. Provide other joints as shown.

3.03 CURING AND PROTECTION

A. Cure and protect topping applications and finishes as specified in Section "03301 Concrete."

3.04 PERFORMANCES

A. Failure of concrete topping to bond to substrate (as evidenced by a hollow sound when tapped), or disintegration or other failure of topping to perform as a floor finish, will be considered failure of materials and workmanship. Repair or replace toppings in areas of such failures, as directed.

3.05 MATERIAL

A non-toxic solvent free high build, protective epoxy resin coating.

A. **Primary Uses:**

- For the internal protection of concrete.
- As an impervious, resilient and chemically resistant floor.
- As a protective and decorative coating in the project.

B. Appearance and finish: The material should be High, gloss, heavy bodied, ultra dense surface. Hygienic and easily cleaned. Standard colours should be light and dark grey.

C. It must have the following Advantages

- Durable
- Non-toxic
- Waterproof and protective

- High chemical resistance
- Solvent free
- Easily applied by brush or roller.

D. Typical properties

Pot life at 30°C	*30 minutes*
Mixed density	*1.6gm/cm² at 25°C*
Track free time	*Approx. 4 hours at 35°C*
Initial cure:	*12 hours at 30°C*
Final cure:	*4 days at 30°C*
Coverage:	*0.29 - 0.40kg /m² /coat*
Finish film thickness:	*180 - 240 microns per coats*
Bond to concrete	*In excess of the cohesive strength of concrete*

E. The Product must be Approve by Engineer. Water Researched Approval for use with Potable Water.

F. Application Procedure:

1. Surface preparation: The substrate should be a smooth or semi-smooth sound surface such as concrete or metal. It is most important to ensure that thorough surface preparation is undertaken prior to application of the protective epoxy resin coating.

a. Concrete:

Ensure concrete is free from excessive laitance, grease, oil, curing compound, etc. Ensure concrete is sound, cutting back where necessary and making using good protective epoxy resin compound. Ensure all blow holes and surface imperfections are made good prior to the application.

MASTERSEAL 180 coating.Ensure concrete is at least 28 days old. Contamination by oil, grease, fats etc. must be removed before other forms of preparation begin. Remove laitance to expose blow holes, by light grit blasting.

b. Steel:

All previous surface treatment should be removed taking the surface back to base metal. The base metal should be abraded and preferably shot blasted with grit, steel shot or propriety abrasive. Where shot blasting is impractical pre-treatment may be carried out with preumatic

de-scaling guns, tap hammers, rotary wire brushes or by flame scaling.

c. Mixing:

MASTERSEAL 180 is supplied in two pre-weighed components, base and reactor, or use any other material approved by the Architect. No additions or omissions are required. Add reactor contents to the base component and mix thoroughly for using a slow speed drill fitted with a suitable mixing paddle until a uniform streak free colour is achieved.

G. **Application:** MASTERSEAL 180 (or any other good quality material approved by the Architect) coating should be applied using good quality rollers or short haired brushes or by airless spray. It is recommended that MASTERSEAL 180 coating be applied in two coats of contrasting colours to ensure complete coverage.

Prior to the application of each coat the surface should be examined for signs of pin-holing, etc. Where pin-holing is evident these should be filled using CONCRESIVE 2200 thixotropic epoxy resin filler, or equivalent as approved by the Architect.

If the application is delayed more than 16 hours at 40°C or 36 hours at 20°C after the previous coat (the higher the ambient temperature, the shorter the maximum period), then the previous coat must be thoroughly abraded to give an adequate mechanical key and solvent wiped.

1. Airless Spray:

For application by airless spray, use a 45.1 or higher ratio pump, minimum 9mm dia hoses and HD tip 19-23 thou.

2. Over coating:

Where areas need to be over coated due to damage etc. it is important that the areas to be treated are well abraded using a stiff rotary wire brush or coarse sand paper to give an adequate key. Completely strip off any unsound coating and proceed with over coating as for new work.

H. **Chemical resistance** MASTERSEAL 180 or other material (approved by the Architect) should be resistant to the following typically encountered chemicals:

a. Formaldehyde, 40% solution

b. Sulphuric Acid, 50% solution

c. Hydrochloric Acid, 50% solution

d. Lactic Acid, 50% solution

e. Nitric Acid, 10% solution

f. Sodium Hydroxide, 50% solution

g. Diesel oil~ Wine

h. Sea and brackish water

i. Aviation hydraulic fuels (Skydrol)

j. Vegetable oils

I. Specification Clause MASTERSEAL 180: Where indicated, apply MASTERSEAL 180 protective epoxy coating as manufactured by MBT or similar approved to the following specification:

Composition: Two component, non-toxic, pigmented solvent less a epoxy resin based compound.

Coverage: 0.29 to 0.40kg/m^2/coat, two coats are

recommended. Dry film thickness: 180 to 240 microns/coat.

J. Storage Store under cover out of direct sunlight and protect from extremes of temperature. In tropical climates the product must be stored in an air conditioned environment. Failure to comply with the recommended storage conditions may result in premature deterioration of the product or packaging. For specific storage advice consult the Architect.

K. Safety Precautions As with all chemical products, care should be taken during use and storage to avoid contact with eyes, mouth, skin and foodstuffs. Treat splashes to eye and skin immediately. If accidentally ingested, seek immediate medical attention. Keep away from children and animals. Reseal containers after use. For further information, refer to material safety data sheet.

3.06 ACCEPTED MATERIALS

A. TASKI H-16 (Pore Filter, Based on Acrylic Polymer)

B. FOSROC FC-100

C. MASTERSEAL 180

D. Or Equal as Approved by the Architect.

3.07 SPECIAL NOTE

The hardener topping is carried out in 2 stages

A. Stage 1: Apply powder based hardener as detailed in Clause 2 & 3.

B. Stage 2: Apply dust proofing as detailed in Clause 3.05 / 3.06. The stage 1 & 2 are complimentary to each other.

SECTION 8 - CEMENT-BASED SCREED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Standard aggregate concrete leveling floor screeds.
2. Roof screeds necessary to provide roof slopes.

B. Related Sections include the following:

1. Division 7 Section "Joints Sealants".
2. Division 9 Section "Resinous Flooring".
3. Division 9 Section “Ceramic Tiles”.

1.3 DEFINITIONS

A. **Screed:** A layer of cement-sand or concrete mix, with or without reinforcement, applied over structural floor or roof deck slab to achieve correct level and receive another finish material.

1.4 SUBMITTALS

A. **Product Data:** For each type of product indicated.

B. **Mix Design and Test Reports:** For each mix used for screeds.

C. Joint details and arrangements.

D. Test reports for field control testing.

1.5 QUALITY ASSURANCE

A. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.7 PROJECT CONDITIONS

A. **Environmental Limitations:** For proprietary products, comply with manufacturer's written recommendations for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting screed performance.

B. Close areas to traffic during screed application and for appropriate time period after application as recommended in writing by the manufacturer.

1.8 COORDINATION

A. Coordinate cement-based screed with requirements of finish flooring products, including adhesives, specified in Division 9 Sections.

PART 2 – PRODUCTS

2.1 SCREED MATERIALS

A. **Cement:** ASTM C 150, Type I, ordinary Portland cement.

B. **Normal-Weight Aggregate:** ASTM C 33 and as follows:

1. Fine aggregate, consisting of sand or crushed stone screenings, clean, hard, free of deleterious matter. Grade according to approval design mix.
2. Coarse aggregate, consisting of gravel or crushed stone, clean, hard, free of deleterious matter. Grade according to approval design mix.

C. **Water:** Potable and at a temperature of not more than 21 deg. C.

2.2 REINFORCEMENT

A. **Fibrous Reinforcement:** 100% virgin polypropylene, fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Proportion shall be in accordance with the written manufacturer instructions of the manufacturer.

1. Specific Gravity: 0.91.
2. Tensile strength: 345 - 758 N/mm^2.

B. **Galvanized Plain-Steel Welded Wire Fabric:** For screeds 70 mm deep and more is to be electrically welded, fabricated from galvanized steel wire into flat sheets, 150 x 150 mm mesh and 3.00 mm minimum wire diameter.

2.3 CURING MATERIALS

A. **Absorptive Cover:** AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 305 g/sq. m when dry.

B. **Water:** Potable.

2.4 DESIGN MIXES

A. Prepare design mixes for each type and strength of cement-based screed by either laboratory trial batch or field-test data methods. For trial batch method, use an approved qualified independent testing agency for preparing and reporting proposed mix designs.

B. Limit water-soluble chloride ions to the maximum percentage by weight of cement or cementitious material permitted by ACI 301.

C. Minimum Compressive Strength after 28 days is to be as follows:

1. 220kg/cm2 for screed with fine concrete mix (coarse aggregate of maximum size of 10 mm is used).
2. 180 kg/cm2 for cement-sand screeds.

2.5 RELATED MATERIALS

A. **Joint-Filler Strips:** ASTM D 1752, cork or self-expanding cork.

B. Water: Potable.

C. **Acrylic-Bonding Agent:** ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. **Admixtures:** Admixtures certified by manufacturer to contain not more than 0.1 %

water-soluble chloride ions by mass of cementitious material and compatible with other admixture and cementitious materials. Do not use admixtures containing calcium chloride.

E. **Epoxy Adhesive:** ASTM C 881, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

2.6 MIXING

A. **Bonding Slurry:** Mix 1 part Portland cement and 2 parts sand with water and an acrylic-bonding agent according to manufacturer's written instructions to a thick paint consistency.

B. **Screed Mix:** Design mix, with or without admixture, to produce a mix with the following characteristics:

1. Minimum Compressive Strength: As specified.
2. Maximum Slump: 125 mm.
3. Mix proportions: Submit proposed mix design for approval.
4. Minimum Cement-Sand Ratio: Not less than 1:4 by volume.
5. Maximum Water-Cement Ratio: 0.51.
6. Mix screed materials, admixtures and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates for conditions affecting performance of screed. Proceed with application only after unsatisfactory conditions have been corrected.

B. Verify that base slabs meet finish and surface profile requirements in Division 3 Section "Cast-in-Place Concrete."

3.2 PREPARATION

A. **Existing Concrete:** Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of 6 mm.

1. Prepare and clean existing base slabs according to topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
2. Mechanically remove contaminants from existing concrete that might impair bond of topping.

B. Install joint-filler strips where screed abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with screed surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips 13 mm below screed surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.3 SCREED APPLICATION

A. **Fibrous Reinforcement:** For screeds of depth less than 70 mm, apply fibrous reinforcing as per manufacturer's written instructions.

B. **Reinforcing Mesh:** Screeds 70 mm deep and more shall have a reinforcing layer at mid height. Reinforcement shall be as specified this Section. Place steel wire mesh with reinforcing wire parallel to longest dimension of screed bay. Cut mesh to fit around roof openings and projections. Terminate mesh at control joints. Lap sides and ends of mesh at least 150 mm.

C. **Deferred Screed:** Mix and scrub bonding slurry into dampened concrete to a thickness of 1.5 to 3 mm, without puddling. Place screed while slurry is still tacky.

D. Place screed continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

1. Screed surface with a straightedge and strike off to correct elevations.

2. Slope surfaces uniformly where indicated.

3. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

E. **Finishing:** Consolidate surface with power-driven floats as soon as screed can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate screed by power-driven trowel so no blisters develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.

a. Finish and measure surface so gap at any point between screed surface and an unleveled freestanding 3 m long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed 3 mm.

F. **Construction Joints:** Construct joints true to line with faces perpendicular to surface plane of screed, at locations indicated or as approved by the Engineer.

1. Coat face of construction joint with epoxy adhesive at locations where screed is placed against hardened or partially hardened screed.

G. **Contraction Joints:** Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 3 mm wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before screed develops random contraction cracks.

1. Form joints in screed over contraction joints in base slabs, unless otherwise indicated.

2. Construct contraction joints for a depth equal to one-half of screed thickness, but not less than 13 mm deep.

H. **Screed Mix:** Use cement-sand mix for screeds less than 70 mm in depth. Use fine concrete mix for 70 mm deep and more.

3.4 PROTECTION AND CURING

A. **General:** Protect freshly placed screed from premature drying and excessive cold or hot temperatures.

B. Begin curing immediately after finishing screed. Cure by one or a combination of the following methods, according to screed manufacturer's written instructions:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with water or absorptive cover, water saturated and kept continuously wet. Cover screed surfaces and edges with 300 mm lap over adjacent absorptive covers.

3.5 REPAIRS

A. **Defective Screed:** Repair and patch defective screed areas, including areas that have not bonded to concrete substrate.

3.6 FIELD QUALITY CONTROL

A. **Sample Sets:** At point of placement, testing and inspecting agency shall take a set of 3 molded-cube samples from the screed mix for the first 90 sq. m plus 1 set of samples for each subsequent 450 sq. m of screed, or fraction thereof, but not less than 6 samples for each day's placement. Samples shall be tested according to ASTM C 109M for compliance with compressive strength requirements.

3.7 CLEANING AND PROTECTING

A. Protect screeds from damage and wear during the remainder of construction period. Use protective methods and materials approved by the Engineer, including temporary covering.

B. Clean screeds not more than 4 days before dates scheduled for inspections intended to install final finishes.

SECTION 9 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section covers the work of concrete masonry assemblies and includes:

1. Non-fire rated masonry assemblies.
2. Fire rated masonry assemblies.
3. Reinforced masonry assemblies.

B. This Section includes unit masonry assemblies consisting of the following:

1. Concrete Masonry Units.
2. Mortar and Grout Materials.
3. Ties and Anchors.
4. Miscellaneous Masonry Accessories.
5. Mortar and Grout Mixes.
6. Joint Reinforcement.
    a. Horizontal reinforcement.
    b. Vertical reinforcement.

C. Related Sections include the following:

1. Division 3 Section "Cast-In-Place Concrete" for cast-in-place reinforced concrete lintels and other work items as indicated on Drawings.
2. Division 5 Section "Steel Structural" for coordinating welding requirements with steel alloy used for structural steel works.
3. Division 5 Section "Metal Fabrications" for steel lintels.
4. Division 7 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
5. Division 7 Section "Through-Penetration Firestop Systems" for sealing systems of penetrations and opening in fire rated masonry assemblies.
6. Division 7 Section "Joint Sealants".
7. Division 9 Section “Portland Cement Plaster” for Portland Cement Plaster finish.

D. Products installed, but not furnished, under this Section include the following:

1. Hollow-metal frames in unit masonry openings, furnished under Division 8, Section "Custom Steel Doors and Frames."
2. Steel Lintels for Unit Masonry Specified in Division 5 “Metal Fabrications”.

3. Manufactured reglets in masonry joints for metal flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."

1.3 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops the net-area compressive strengths (f'm) at 28 days indicated in part 2.

1. For Concrete Unit Masonry: As follows, based on net area:

   a. f'm = 10.3 MPa.

1.4 SUBMITTALS

A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.

B. Shop Drawings: Shop drawings including full details of masonry works for different assemblies and covering anchorage to concrete elements cavity walls and flashings, masonry reinforcement, bond pattern, joints, horizontal joint reinforcement, openings, lintels and other details as the Engineer may require.

C. Samples: For the following:

1. Full-size units for each different exposed masonry unit required, showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction.
2. Accessories embedded in the masonry.
3. Reinforcing bars and accessories.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Material Test Reports: From a qualified independent testing agency employed and paid by contractor or manufacturer indicating and interpreting test results relative to compliance of the following proposed masonry materials for compliance with requirements indicated:

1. Each type of masonry unit required.
   a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
   b. Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.
2. Mortar complying with property requirements of ASTM C 270.
3. Grout mixes, Include description of type and proportions of grout ingredients.

F. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:

1. Each type of masonry unit required.
   a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
   b. Include test data, measurements, and calculations establishing net-area compressive strength of masonry units.

2. Each cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
3. Each combination of masonry unit type and mortar type. Include statement of net-area compressive strength of masonry units, mortar type, and net-area compressive strength of masonry determined according to test methods stated in Clause 1.5/F of this Section.
4. Each material and grade indicated for reinforcing bars.
5. Each type and size of anchor, tie, and metal accessory.
6. Each type and size of joint reinforcement.

1.5 QUALITY ASSURANCE

A. **Contractor** shall perform a survey and inspection of foundations for compliance with dimensional tolerances. Full comprehensive report shall be submitted to the Engineer prior to commencing building masonry assemblies on foundations.

B. **Quality System**: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

C. **Testing Agency Qualifications**: To qualify for acceptance, an independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM C 1093, that it has the experience and compatibility to satisfactorily conduct the testing indicated without delaying the work.

D. **Preconstruction Testing**: Employ and pay a qualified independent testing agency to perform the following preconstruction testing to establish compliance of proposed materials and construction with specified requirements:

1. Concrete Masonry Unit Test: For each concrete masonry unit indicated, test units for strength, absorption, and moisture content per ASTM C 140.
2. Prism Test: For each type of wall construction indicated, test masonry prisms per ASTM E 447, Method B.
3. Mortar Test: For mortar properties per ASTM C 270.
4. Grout Test: For compressive strength per ASTM C 1019.
5. Evaluate mortar composition and properties per ASTM C780.

E. **Fire-Resistance Ratings:** Where indicated on Drawings, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to Engineer.

F. Minimum fire rating for concrete unit masonry assemblies, including 15 mm cement plaster facing on both sides shall be as follows:

a. 100 mm solid blocks: 2 hrs.
b. 150 mm solid blocks: 4 hrs.
c. 100 mm hollow blocks: 1 hrs.
d. 150 mm hollow blocks: 1-1/2 hrs.
e. 200 mm hollow blocks: 3 hrs.

G. **Mockups:** Before installing unit masonry, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of

materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Locate mockups in the locations indicated or, if not indicated, as directed by Engineer.
2. Build mockups of reinforced assembly, double walls, typical cavity wall and single-wythe wall areas as shown on Drawings.
3. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
4. Protect accepted mockups from the elements with weather-resistant membrane.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, unless such deviations are specifically approved by Engineer in writing.
7. Approved mockups will become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are in an air-dried condition.

1. Protect Type I concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. **Protection of Masonry:** During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 600 mm down both sides and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 600 mm down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. **Stain Prevention:** Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. **Hot-Weather Requirements:** Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.

1. When ambient temperature exceeds 35 deg C, or 32 deg C with a wind velocity greater than 13 km/h, do not spread mortar beds more than 1200 mm ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. General: Provide shapes indicated and as follows for each form of concrete masonry unit required**.**

1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners, unless indicated as bullnose.
3. Provide bullnose units for outside corners, unless otherwise indicated.
4. Types of concrete masonry shall be as follows:
   a. Use solid blocks for all below-grade assemblies.
   b. Use solid blocks for walls, partitions or wythes to be finished with mechanically attached dimension stone cladding.
   c. Use solid blocks or units for 4” thick partitions.
   d. Use units open from both sides for reinforced masonry assemblies.
   e. Use cellular blocks (open from one side) for other assemblies.

B. Concrete Masonry Units: ASTM C 90 and as follows**:**

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength specified in Clause 1.3/A of this Section.
2. Weight Classification: Normal weight.
3. Provide moisture-controlled units. All masonry units shall be factory cured.
4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
   a. Where units are to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.
5. Cement: ASTMC 150, Type I, Gray color.
6. Aggregates: Do not use aggregates made from pumice, scoria, or tuff.

2.2 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I. Provide gray color.

B. Hydrated Lime: Do not use Lime.

C. Pre-Packaged Portland Cement Mix: Pre-Packaged blend of Portland cement, water, and aggregate complying with requirements specified in this Article combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C 1142. Compressive strength at 28 days shall not be less than 5 MPa (minimum cement sand ratio 1:3-4 by volume).

D. Aggregate for Mortar: ASTM C 144.

1. White-Mortar Aggregates: Natural white sand or ground white stone.

E. Aggregate for Grout: ASTM C 404.

F. Water: Potable.

2.3 REINFORCED STEEL BARS

A. Deformed High Yield Steel Bars: BS 4449, Grade 460.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 4.8-mm steel wire, hot-dip galvanized after fabrication.

a. Provide units with either two loops or four loops as needed for number of bars indicated or calculated.

2.4 TIES AND ANCHORS, GENERAL

A. General: Provide ties and anchors, specified in subsequent articles that comply with requirements for metal and size of this Article, unless otherwise indicated.

B. Wire: As follows:

1. Stainless-Steel Wire: ASTM A 580, Type 304.
2. Wire Diameter: 6.4 mm.

C. Stainless Steel Sheet: As follows:

1. Stainless-Steel Sheet: ASTM A 167, Type 304.
2. Stainless-Steel Sheet Thickness: 2.8 mm.

D. Stainless-Steel Plates, Bars, and Dowels: ASTM A 167, ASTM A 276, or ASTM A 666, Type 304; temper as required to support loads imposed without exceeding allowable design stresses.

2.5 ADJUSTABLE ANCHORS FOR CONNECTING TO STRUCTURAL STEEL FRAME

A. **General:** Provide two-piece assemblies as described below, allowing vertical or horizontal differential movement between wall and frame parallel to plane of wall but resisting tension and compression forces perpendicular to it.

1. Manufacturer's standard anchors with crimped 6.4 mm diameter wire anchor section for welding to steel and triangular-shaped wire tie section sized to extend within 25 mm of masonry face and as follows:

2. Welding to Steel Structural Framing: Comply with requirements specified in Division 5, Section “Structural Steel”.

3. Touch-Up Painting: Paint welds with two coats of zinc rich paint to ASTM A 780.

B. **Wire Diameter:** 6.4 mm.

2.6 ANCHORS FOR CONNECTING TO CONCRETE

A. **General:** Provide two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section: Dovetail anchor section formed from 1.6-mm thick, stainless-steel sheet.

2. Tie Section: Triangular-shaped wire tie, sized to extend within 25 mm of masonry face, made from 6.4-mm diameter.

2.7 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron inserts of type and size indicated.

B. Anchor Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563M hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:

1. Headed bolts.

2. Nonheaded bolts, straight.

C. Post installed Anchors: Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Type: Expansion anchors.

2. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1service condition (mild).

3. For Postinstalled Anchors in Concrete: Capability to sustain, without failure, a load equal to four times the loads imposed by masonry.

4. For Postinstalled Anchors in Grouted Concrete Masonry Units: Capability to sustain, without failure, a load equal to six times the loads imposed by masonry.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. **Compressible Filler:** Premolded filler strips complying with ASTM D 1056, Type 2, Class A, Grade 1; compressible up to 35 percent; of width and thickness indicated; formulated from the following material:

1. Urethane.

B. **Firestop Joint Filler:** UL classified R 9073, fire rating to match masonry assembly, smoke seal material in the form of boards, easy cut and fit and meeting the following requirements:

1. Service range: up to 1260 deg. C.
2. Melting point: 1760 deg. C
3. Flame spread: 5 to ASTM E 84
4. Smoke developed: 0 to ASTM E 84
5. Fuel contributed: 0 (non-combustible to ASTM E 136)
6. Compression strength: 2.46 kg/cm2 minimum at 10% deformation.
7. Intensity: 224/256 kg/m3.

Thickness is to be manufacturer's standard to fit for thickness of joints indicated on Drawings.

C. **Preformed Control-Joint Gaskets:** Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

1. Styrene-Butadiene-Rubber Compound: ASTM D 2000, Designation M2AA-805.
2. PVC: ASTM D 2287, Type PVC-65406.

D. **Bond-Breaker Strips:** Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

E. **Rectangular Plastic Weep/Vent Tubing:** Clear butyrate, 9 by 40 by 90 mm.

2.9 MORTAR AND GROUT MIXES

A. **General:** Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. All cement used shall be ordinary Portland (ASTM C 150, Type I).

B. **Pre-blended, Dry Mortar Mix:** Furnish dry mortar ingredients in the form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

1. Standard: ASTM C270, lime-free Portland cement based.
2. Wet Mix Life: Less than 1.5 hours.
3. Initial Adhesion at 28 days: Not less than 0.3 N/mm2.
4. Bending Strength: Around 1 N/ mm2.
5. Compressive Strength: Not less than 5 ±1 N/ mm2.
6. Minimum Cement Sand Mix: 1:3
7. Testing: ASTM C 780.

C. **Job-Mixed Mortar:** Comply with ASTM C 270 as follows:

1. Bending Strength: Around 1 N/ mm2.
2. Compressive Strength: Not less than 5 ±1 N/ mm2.
3. Minimum Cement Sand Mix: 1:3.

4. Testing: ASTM C 780.

5. Limit Cementitious materials in mortar to Portland cement and lime.

6. Do not add lime to the mix. Approved liquid admixtures that substitute the performance of lime may be added to the mix.

D. **Grout for Unit Masonry:** Comply with ASTM C 476. Unless otherwise specified, use grout of consistency indicated or, if not otherwise indicated, of consistency (fine or coarse) at time of placement that will completely fill spaces intended to receive grout.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with ASTM C 476 for dimensions of grout spaces and pour height.

2. Provide grout with a slump of 200 to 275 mm as measured according to ASTM C 143.

3. Use fine grout (maximum size of coarse aggregate is 10 mm) in grout spaces less than 100 mm in least horizontal dimension, unless otherwise indicated.

4. Use coarse grout in grout spaces 100 mm or more in least horizontal dimension, unless otherwise indicated.

5. The Contractor shall submit laboratory design mix of concrete grout to obtain performance specified in of this Sub-Clause. Minimum cement content shall be 300 kg/m^3.

6. Compressive Strength: Minimum 17.5 MPa at 28 days.

7. Grout shall be mixed in proportions according to approved design mix to obtain compressive strength specified using the minimum quantity of water to ensure the necessary fluidity and to render it capable of penetrating the work.

8. Concrete grout shall be used or filling hollow cells in bond beams, under concrete lintels and bond beams, in window and door jambs and other locations for reinforced masonry assemblies as specified. Grout shall be mechanically mixed in drum mixers in volumetric proportions with only enough water shall be added to the mixture to produce a mixture which is flowable, but which will not show an excess of water when placed.

2.10 JOINT REINFORCEMENT

A. **General:** Provide joint reinforcement formed from the following:

1. Stainless-steel wire, ASTM A 580, Type 304.

B. **Description:** Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 3 m, with prefabricated corner and tee units, and complying with requirements indicated below:

1. Wire Diameter for Side Rods: 4.8 mm.

2. Wire Diameter for Cross Rods: 4.8 mm.

C. For single-wythe masonry, provide type as follows with single pair of side rods:

1. Truss design with continuous diagonal cross rods spaced not more than 407 mm o.c.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions, with installer present for compliance with requirements for installation tolerances and other conditions affecting performance of unit masonry. Do not proceed with installation until unsatisfactory conditions have been corrected.

1. For the record, prepare written report, listing conditions detrimental to performance.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.2 INSTALLATION, GENERAL

A. **Thickness:** Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specification.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.

D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting, where possible. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. **Wetting of Brick:** Wet brick before laying. Allow units to absorb water so they are damp but not wet at the time of laying.

3.3 CONSTRUCTION TOLERANCES

A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:

1. Variation from Plumb: For vertical lines and surfaces of columns, walls, and arrises, do not exceed 3 mm in 3 m, nor 5 mm in 6 m, nor 6 mm in 12 m or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 3 mm in 6 m, nor in 12 m or more. For vertical alignment of head joints, do not exceed plus or minus 3 mm in 3 m, nor 6 mm maximum.
2. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 3 mm in 6 m, nor 6 mm in 12 m or more. For top surface of bearing walls, do not exceed 2 mm in 3 m, nor 1.0 mm within width of a single unit.
3. Variation of Linear Building Line: For position shown in plan and related

portion of columns, walls, and partitions, do not exceed 6 mm in 6 m, nor 10 mm in 12 m or more.

4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 5 mm nor plus 10 mm.

5. Variation in Mortar-Joint Thickness: Do not vary from bed-joint thickness indicated by more than plus or minus 3 mm, with a maximum thickness limited to 12 mm. Do not vary bed-joint thickness from bed-joint thickness of adjacent course by more than 3 mm. Do not vary from head-joint thickness indicated by more than plus or minus 3 mm. Do not vary head-joint thickness from adjacent head-joint thickness by more than 3 mm. Do not vary from collar-joint thickness indicated by more than minus 3 mm or plus 10 mm.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. **Bond Pattern for Exposed Masonry:** Lay exposed masonry in the following bond pattern; do not use units with less than nominal 100-mm horizontal face dimensions at corners or jambs.

1. One-half running bond with vertical joint in each course centered on units in courses above and below.

C. **Connection Between Walls And Partitions:** walls and partitions should generally be bonded, tied or dowelled to one another at angles and junctions. Where it is necessary for a partition to be connected to an adjacent wall, this should be done by toothing or block bonding unless otherwise specified

D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 50 mm. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 100-mm horizontal face dimensions at corners or jambs.

E. **Stopping and Resuming Work:** In each course, rack back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.

F. **Built-in Work:** As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.

G. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.

1. At exterior frames, insert extruded polystyrene board insulation around perimeter of frame in thickness indicated, but not less than 19 mm to act as a thermal break between frame and masonry.

H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

I. Fill cores in hollow concrete masonry units with grout 600 mm under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

J. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Wedge non-load-bearing partitions against structure above with small pieces

of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3. At fire-rated walls or partitions, install firestopping joint filler as specified in this Section in joint between top of partition and underside of structure. Fill joints at both faces with fire rated elastomeric silicone sealants to comply with a UL-listed joint system at head of wall. Comply with requirements of Division 7, Section “Joint Sealants”.

K. Lay walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow masonry units as follows:

1. With full mortar coverage on horizontal and vertical face shells.

2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.

3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.

4. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 10-mm joints.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. **General:** Provide continuous masonry joint reinforcement as indicated below. Install entire length of longitudinal side rods in mortar with a minimum cover of 16 mm on exterior side of walls, 13 mm elsewhere. Lap reinforcement a minimum of 150 mm.

1. Space reinforcement not more than 406 mm o.c.

2. Space reinforcement not more than 203 mm o.c. in foundation walls and parapet walls.

3. Provide reinforcement in mortar joint 1 block course above and below wall openings and extending 305 mm beyond openings.

   a. Reinforcement above is in addition to continuous reinforcement.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL JOINTS

A. **General:** Install control joints in unit masonry at maximum intervals of 6.00 meters length and where indicated. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.

2. Install preformed control-joint gaskets designed to fit standard sash block.

3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake joint.

4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete.

3.8 FIRE RATED MASONRY ASSEMBLIES

A. **Fire Rating:** As indicated on Drawings.

B. **Thickness:** As required to satisfy fire rating indicated but not less than thickness indicated on Drawings.

C. **Unit Type:** As required to satisfy fire rating indicated in compliance with requirements specified in this Section.

D. Care shall be exercised to solidly fill all joints, vertical and horizontal, with mortar.

E. Joints: To structure above or adjoining are to be prefabricated, fire rated joint system comprising fire rated compressible filler and fire rated joint sealant on each face of the assembly, labeled by UL as rated for fire rating indicated.

F. Penetrations through fire rated masonry walls shall be sealed and treated with material systems as specified in Division 7, Section “Through Penetration Fire Stop Systems”.

G. Where required, expansion joints through fire rated concrete masonry walls or at the intersection between concrete masonry walls and other walls or partition shall be 60 or 120 minutes fire rated construction. Use firestop joint filler as specified in this Section and fire rated joint sealant on each face of the assembly. Comply with Division 7, Section “Joint Sealants”.

H. All accessories used in construction of fire rated assemblies shall be certified as suitable for use in fire rated masonry assemblies of rating indicated.

3.9 REINFORCED UNIT MASONRY INSTALLATION

A. **Temporary Formwork and Shores:** Construct formwork and shores to support reinforced masonry elements during construction.

1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. **Placing Reinforcement:** Comply with requirements of requirements of Division 3, Section “Cast-In-place concrete”.

C. **Grouting:** Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

1. Comply with requirements of ACI 530.1 or Section 2104.6 in the Uniform Building Code (UBC) for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.10 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 15 mm in width between masonry and structural member, unless otherwise specified. Keep open space free of mortar or other rigid materials.
2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 620 mm o.c. vertically and 920 mm o.c. horizontally.
4. Fill space with compressible joint filler and seal edges flush with joint sealant, unless otherwise indicated. Comply with Division 7, Section "Joint Sealants".

3.11 ANCHORING MASONRY TO CONCRETE COLUMNS AND WALLS

A. Anchor masonry to concrete where masonry abuts or faces concrete columns or walls, comply with the following:

1. Anchor masonry to concrete with metal anchors embedded as specified in masonry joints and attached to concrete.
2. Space anchors as indicated, but not more than 420 mm o.c. vertically and 915 mm o.c. horizontally.

3.12 FIELD QUALITY CONTROL

A. Engage a qualified independent testing agency to perform field quality-control testing indicated below.

1. Retesting of materials failing to meet specified requirements shall be done also at Contractor's expense.

B. **Concrete Masonry Unit Tests:** For each type of concrete masonry unit indicated, units shall be sampled and tested for strength and absorption, according to ASTM C 140.

C. **Testing Frequency:** Tests and Evaluations listed in Sub-clause D, E and F of this Article will be performed during construction for each 460 sq. m of wall area or portion thereof.

D. Mortar properties will be tested per ASTM C 270.

E. Grout will be sampled and tested for compressive strength per ASTM C 1019.

F. **Prism-Test Method:** For each type of wall construction indicated, masonry prisms will be tested per ASTM E 447, Method B, and as follows:

1. Prepare 1 set of prisms for testing at 7 days and 1 set for testing at 28 days.

G. Mortar composition and properties will be evaluated per ASTM C 780.

H. **Evaluation of Quality-Control Tests:** In the absence of other indications of noncompliance with requirements, masonry will be considered satisfactory if results from construction quality-control tests comply with minimum requirements indicated.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. **Pointing:** During the tooling of joints, enlarge voids and holes, except weep holes,

and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.

C. **In-Progress Cleaning:** Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

3.14 LINTELS

A. **Steel Lintels:** As specified in division 5, Section “Metal Fabrications”.

B. Concrete Lintels:

1. Precast lintels: Comply with requirements of Division 3, Section “Plant Precast Structural Concrete”.
2. Cast-In-Place Concrete lintels: Comply with requirements of Division 3, Section “Cast-In-Situ Concrete”.

C. Provide steel lintels where openings up to 610 mm wide are indicated.

D. Provide reinforced concrete lintels where shown and where openings of more than 610 mm are shown without structural steel or other supporting lintels.

E. Provide minimum bearing of 200 mm at each jamb, unless otherwise indicated.

SECTION 10 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section covers items fabricated from steel, stainless steel or aluminum and are not covered under other Specification Sections, including, but not limited to, the following:

1. Miscellaneous framing and supports.
    a. Concealed applications where framing and supports are required.
    b. Countertop support.
    c. Vanity supports
    d. Steel framing and supports for mechanical and electrical equipment.
    e. Steel framing and supports for Architectural applications.
2. Elevator machine beams, hoist beams, and divider beams.
3. Support angles for elevator door sills.
4. Shelf angles.
5. Loose bearing and leveling plates.
6. Steel welded plates and angles for casting into concrete not specified in other Sections.
7. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.

B. This Section includes the following metal fabrications:

1. Ladders.
2. Floor plate and supports.
3. Cast nosing, treads, and thresholds.
4. Pipe guards.
5. Pipe bollards.
6. Column protection guard.

C. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.

2. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

D. Related Sections include the following:

1. Division 3 Section "Cast-In-Situ Concrete" for corner guards to be placed in forms of reinforced concrete columns and for concrete footings required for metal fabrications.

2. Division 4 Section "Unit Masonry Assemblies" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.

3. Division 5 Section "Structural Steel" for structural-steel framing system components.

4. Division 9 Section “Painting” for field applied paint finishes.

5. Division 14 Section "Electric Traction Elevators" for elevator pit ladders and support angles for elevator doors sills.

1.3 DESIGN REQUIREMENTS

A. Design Requirements: Design, engineer, fabricate, and install work in compliance with specified standards, performance requirements, material selections, and requirements of this Section and related sections.

1. Provide work to withstand thermal movement, wind pressure, gravity loads, seismic loads and movement of building structure without failure. Work to remain free from defects.

a. **Seismic Load:** Uniform Building Code, 1997 Edition, zone 2A.

b. **Wind Loads:** Provide exterior metal fabrications that withstand design wind pressure calculated according to Uniform Building Code (UBC), 1997 Edition, Exposure C, and Basic Wind Speed 130 Km/hr.

c. **Thermal Movements:** Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1) Temperature Change (Range): 35 deg C, ambient; 65 deg C, material surfaces.

B. The design shall ensure that all components including anchors and connections shall comply with the allowable stresses as per relevant ASTM Standards. Load combinations shall be chosen to ensure that no element shall exceed the allowable stresses under any case of loading.

1.4 SUBMITTALS

A. **Product Data:** for non-slip aggregates and non-slip aggregate surface finishes, cast nosing, treads and thresholds, steel floor plate, paint products, and grout.

B. **Shop Drawings:** Detail fabrication and erection of each metal fabrication indicated. 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.

C. Samples representative of materials and finished products as may be requested by Engineer.

D. **Mill Certificates:** Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

E. **Welding Certificates** signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

F. **Qualification Data:** For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 900 1/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

B. **Fabricator Qualifications:** A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in- service performance, as well as sufficient production capacity to produce required units, without delaying the work.

C. **Engineering Responsibility:** Engage a fabricator who utilizes a qualified and experienced structural engineer to prepare design calculations, shop drawings, and other structural data.

Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.2, "Structural Welding Code--Aluminum."

3. AWS D1.3, "Structural Welding Code--Sheet Steel."

4. AWS D1.6, "Structural Welding Code--Stainless Steel."

5. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

6. Qualification tests according to the Structural Steel Code of Practice Prevailing in the country or other international Code or standard may also be accepted by the Engineer.

1.6 PROJECT CONDITIONS

A. **Field Measurements:** Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with

construction progress to avoid delaying the Work.

1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

1.7 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.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. **Metal Surfaces, General:** For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36M, Tensile strength 400 Pa and minimum yield point 250 MPa.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

C. Stainless Steel:

1. Grade and type designated below for each form required:

   a. Tubing: ASTM A 554, Grade MT 316

   b. Pipe: ASTM A 312M, Grade TP 316.

   c. Castings: ASTM A 743M, Grade CF 8M.

   d. Plate: ASTM A 167, Type 316.

   e. Bar Stock: ASTM A 276.

2. Finish: Bright, directional polish; match AISI No. 4 finish.

D. Rolled-Steel Floor Plate: ASTM A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

F. Steel Tubing: Product type (manufacturing method) and as follows:

1. Cold-Formed Steel Tubing: ASTM A 500.

   a. Provide tubing with hot-dip galvanized coating per ASTM A 53.

G. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

1. Provide galvanized finish for all steel pipe.

H. Malleable-Iron Castings: ASTM A 47M, Grade 22010.

I. Gray-Iron Castings: ASTM A 48M, Class 200, unless another class is indicated or required by structural loads.

J. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

K. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.3 ALUMINUM

A. Aluminum Extrusions: ASTM B 221 M, alloy 6063-T6.

B. Aluminum-Alloy Rolled Tread Plate: ASTM B 632M, alloy 6061-T6.

2.4 PAINT

A. **Shop Primers:** Provide primers that comply with Division 9 Section "Painting."

B. **Shop Primer for Ferrous Metal:** Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

C. **Shop Primer for Ferrous Metal:** Organic zinc-rich primer, complying with SSPC Paint 20 and compatible with topcoat.

D. **Galvanizing Repair Paint:** High-zinc-dust-content paint for re-galvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.

E. **Bituminous Paint:** Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FASTENERS

A. **General:** Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn , where built into exterior walls. Select fasteners for type, grade, and class required.

B. **Bolts and Nuts:** Regular hexagon-head bolts, ASTM F 568M, Property Class 4.6; with hex nuts, ASTM A 563M; and, where indicated, flat washers.

C. **Anchor Bolts:** ASTM F 1554, Grade 36.

D. **Machine Screws:** ASME B18.6.7M.

E. **Lag Bolts:** ASME B18.2.3.8M.

F. **Wood Screws:** Flat head, carbon steel, ASME B18.6.1.

G. **Plain Washers:** Round, carbon steel, ASME B18.22M.

H. **Lock Washers:** Helical, spring type, carbon steel, ASME B18.21 .2M.

I. **Expansion Anchors:** Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 738M and nuts complying with ASTM F 836M.

J. **Toggle Bolts:** FS FF-B-588, tumble-wing type, class and style as needed.

2.6 GROUT

A. **General:** Grout shall meet the requirements of Division 3 section, “Cast-in-Place Concrete”.

B. **Non-shrink, Metallic Grout:** Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.

C. **Non-shrink, Nonmetallic Grout:** Factory-packaged, non-staining, non-corrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.7 CONCRETE FILL

Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 20 MPa, unless otherwise indicated.

2.8 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1 mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. 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 smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

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

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

I. Remove sharp or rough areas on exposed traffic surfaces.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

K. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

2.9 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports indicated or not indicated that are not a part of structural-steel framework as necessary to complete the Work.

B. Fabricate units from structural-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 retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.
2. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 32 mm wide by 6 mm thick by 200 mm long at 600 mm o.c., unless otherwise indicated.
3. Furnish inserts if units must be installed after concrete is placed.

C. Finish:

1. Interior: Prime painted, unless indicated as galvanized.

D. Prime miscellaneous framing and supports with zinc-rich primer.

2.10 RECEIVING STEEL CAGES

Receiving steel cages are to be included in the steelwork package. Cages are to be designed to incorporate the following:

A. Total 7 cages size shown on drawings and 10'-0" high.

B. Cage are to be constructed from steel frames with wire mesh wall and roof cladding. Wire mesh is to be ¼" bars @ maximum 2" centers both ways

C. All cages to have 2 roller shutter doors as indicated on the architectural plans. Doors to type 1 cage to have aluminum doors in accordance with the architectural specifications. Roller shutter door controls to incorporate facility that only one door per cage may be open or partly open at any one time.

D. Design, supply, and insulation to including all fixings, claddings, and flashings required to construct the cages.

E. All materials to be painted in accordance with

specifications. **2.11 SHELF ANGLES**

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 19-mm bolts, spaced not more than 150 mm from ends and 600 mm o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 50 mm larger than expansion or control joint.

B. Galvanize shelf angles located in exterior walls.

C. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles

to cast-in-place concrete.

2.12 LOOSE BEARING AND LEVELING PLATES

A. Column base plates are not included in this category.

B. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of the required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

2.13 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 not less than two integrally welded steel strap anchors for embedding in concrete.

2.14 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 150 mm from each end, 150 mm from corners, and 600 mm o.c., unless otherwise indicated.

C. Galvanize miscellaneous steel trim in the following locations:

1. Exterior.

2. Interior, where indicated.

2.15 LOOSE STEEL LINTELS

A. Unless otherwise indicated on Drawings, provide steel lintels as follows.

B. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

C. Weld adjoining members together to form a single unit where indicated.

D. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than 200 mm, unless otherwise indicated.

E. Galvanize loose steel lintels located in exterior walls.

2.16 STEEL LADDERS

A. **General:** Fabricate ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.

1. Comply with ANSI A14.3, unless otherwise indicated on Drawings.

B. **Side rails:** Continuous, 500 x 10 mm steel flat bars, with eased edges, spaced 460 mm apart.

C. **Bar Rungs:** 20-mm- diameter steel bars, spaced 300 mm o.c maximum.

D. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.

E. Support each ladder at top and bottom and not more than 1500 mm o.c. with welded or bolted steel brackets.

1. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 150 mm.

2. Extend side rails using 30-mm diameter galvanized steel pipes to a height of 0.90 m above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access

F. Provide non-slip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.

G. Galvanize ladders, including brackets and fasteners:

H. Finish is to be field-applied alkyd paint system of color and gloss as selected by the Engineer.

2.17 METAL FLOOR PLATE

A. Fabricate raised-pattern floor plates from rolled-steel floor plate of thickness indicated below:

1. Thickness: As indicated.

2. Pattern: As selected from manufacturer's standard patterns.

B. Fabricate raised-pattern floor plates from rolled-aluminum-alloy tread plate of thickness indicated below:

1. Thickness: 6.00 mm, unless otherwise higher thickness is indicated.

C. Include steel angle stiffeners, and fixed and removable sections as indicated.

1. Provide flush steel bar drop handles for lifting removable sections, one at each end of each section.

2.18 CAST NOSINGS, TREADS, AND THRESHOLDS

A. Fabricate units of material, sizes, and configurations indicated. If not indicated, provide cast-iron units with an integral abrasive finish. Furnish in lengths as required to accurately fit each opening or conditions.

1. Cast units with an integral abrasive grit consisting of aluminum oxide, silicon carbide, or a combination of both.

B. Drill for mechanical anchors with countersunk holes located not more than 100 mm from ends and not more than 300 mm o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by the manufacturer.

1. Provide 2 rows of holes for units over 125 mm wide, with 2 holes aligned at ends and intermediate holes staggered.

C. Apply black asphaltic coating to concealed bottoms, sides, and edges of cast-iron units set into concrete.

D. Provide a plain surface texture, except where fluted or cross-hatched surfaces are indicated.

2.19 PIPE BOLLARDS

A. Fabricate pipe bollards from Schedule 40 steel pipe.

1. Cap bollards with 6-mm- minimum steel plate.

B. Fabricate bollards with 10-mm- thick steel base plates for bolting to concrete slab. Drill base plates at all four corners for 19-mm anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle base plates for plumb alignment of bollards.

C. Finish is to be factory-applied manufacturer's standard thermo setting coating including rust inhibition coat and of minimum dry film thickness of 60 microns.

2.20 COLUMN PROTECTION GUARDS

A. **Metal Protection:** Formed steel plates with welded lugs for building into concrete filling. Galvanize protection after fabrication to be not less than 300 gm/m2 zinc coating intensity.

B. **Pads:** Prefabricated from ASTM D2000, extruded synthetic rubber with type A shore durometer Hardness of 75, plus or minus 5 when tested according to ASTM D2240. Furnish in thickness as recommended by manufacturer for traffic type, but not les than thickness indicated on Drawings.

C. **Filling Concrete:** As specified in this Section.

D. **Finish:** Is to be field-applied epoxy paint system to exposed surfaces of steel and concrete as specified in Division 9 Section “Painting”.

2.21 FINISHES, GENERAL

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.

2.22 STEEL AND IRON FINISHES

A. **Galvanizing:** For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:

1. ASTM A 153 for galvanizing iron and steel hardware.

2. ASTM a 123 for galvanizing both fabricated and UN fabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.76 mm thick or thicker.

B. **Preparation for Shop Priming:** Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.23 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Bright, Directional Polish: No. 4 finish.

D. When polishing is completed, passivity and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.24 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the

Aluminum Association for designating aluminum finishes.

B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

A. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating but with not less 0.025 mm or thicker) complying with AAMA 611

PART 3 - EXECUTION

3.1 PREPARATION

B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

C. Center nosings on tread widths with noses flush with riser faces and tread surfaces.

D. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

A. **Fastening to In-Place Construction:** Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

B. **Cutting, Fitting, and Placement:** Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

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

D. 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.

E. **Field Welding:** Comply with the following requirements:

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 smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. **Corrosion Protection:** Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.3 SETTING BEARING AND LEVELING PLATES

A. Clean concrete and masonry 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 non-shrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations, unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Install with anchorage system indicated to comply with manufacturer's written instructions.

B. Center nosing on tread widths.

C. For nosing embedded in concrete steps or curbs, align nosing flush with riser faces and level with tread surfaces.

D. Seal thresholds exposed to exterior with elastomeric sealant complying with Division 7 Section "Joint Sealants" to provide a watertight installation.

3.5 INSTALLING PIPE BOLLARDS

A. Anchor bollards in place with concrete footings. Support and brace bollards in position in footing excavations until concrete has been placed and cured.

B. Fill bollards solidly with concrete, mounding top surface.

3.6 ADJUSTING AND CLEANING

A. **Touchup Painting:** Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 0.05-mm dry film thickness.

B. **Touchup Painting:** Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."

C. **Galvanized Surfaces:** Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

SECTION 11 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1 Steel pipe and tube handrails and railings

B. Related Sections include the following:

1. Division 9 Section "Painting" for field-applied finish paints.

1.3 PERFORMANCE REQUIREMENTS

A. **General:** In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of handrail and railing materials based on the following:

1. Structural Steel: AISC S335, "Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design with Commentary."

2. Cold-Formed Structural Steel: AISI SG-673, Part I, "Specification for the Design of Cold-Formed Steel Structural Members."

B. **Structural Performance of Handrails and Railings:** Provide handrails and railings complying with requirements of ASTM E 985 for structural performance, based on testing performed according to ASTM E 894 and ASTM E 935.

C. **Thermal Movements:** Provide exterior handrails and railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 35 deg. C, ambient; 65 deg. C, material surfaces.

D. **Control of Corrosion:** Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. **Product Data:** For the following:

1. Manufacturer's product lines of mechanically connected handrails and railings.

2. Grout, anchoring cement, and paint products.

B. **Shop Drawings:** Show fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.

1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. **Samples for Initial Selection:** Manufacturer's color charts showing the full range of colors available for products with factory-applied color finishes.

D. **Samples for Initial Selection:** Short sections of railing or flat, sheet metal samples showing available mechanical finishes.

E. **Samples for Verification:** For each type of exposed finish required, prepared on components indicated below and of same thickness and metal indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1. 150 mm long sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.

2. Fittings and brackets.

3. Assembled sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Sample need not be full height.

F. **Qualification Data:** For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified.

G. Product Test Reports: From a qualified testing agency indicating handrails and railings comply with ASTM E 985, based on comprehensive testing of current products.

1.5 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 900 1/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

B. **Engineering Responsibility:** Engage a qualified structural consulting engineer to prepare design calculations, Shop Drawings, and other structural data.

C. **Consulting Engineer Qualifications:** A consulting engineer who is legally registered and qualified to practice and is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of handrails and railings that are similar to those indicated for this Project in material, design, and extent.

D. **Testing Agency Qualifications:** An independent testing agency, acceptable to the Engineer, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

E. **Source Limitations:** Obtain each type of handrail and railing through one source from a single manufacturer.

F. **Welding:** Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.6 STORAGE

A. Store handrails and railings in a dry, well-ventilated, weather tight place, and protect from damage.

1.7 PROJECT CONDITIONS

A. **Field Measurements:** Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 COORDINATION

A. Coordinate installation of anchorages for handrails and railings. 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.

1.9 SCHEDULING

A. Schedule installation so handrails and railings are mounted only on completed walls. Do not support temporarily by any means that does not satisfy structural performance requirements.

PART 2 – PRODUCTS

2.1 METALS

A. **General:** Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.

B. **Steel and Iron:** Provide steel and iron in the form indicated, complying with the following requirements:

1. Steel Pipe: ASTM A 53; finish, type, and weight class as follows:

   a. Black finish, for welded assemblies

   b. Galvanized finish for mechanical assemblies.

   c. Type F, or Type S, Grade A, Schedule 80, unless higher grade and weight are required by structural loads.

2. Steel Tubing: Cold-formed steel tubing, ASTM A 500, Grade A, unless another grade is required by structural loads.

3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

4. Iron Castings: Malleable iron complying with ASTM A 47M, Grade 22010.

C. **Fittings, Brackets, Flanges, and Anchors:** Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

1. For Welded Assemblies: Provide non-galvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded

in exterior concrete or masonry.

2. For Mechanical Assemblies: Provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

2.2 WELDING MATERIALS, FASTENERS, AND ANCHORS

A. **Welding Electrodes and Filler Metal:** Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. **Fasteners for Anchoring Handrails and Railings to Other Construction:** Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.

1. For steel handrails, railings, and fittings, use plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

C. **Fasteners for Interconnecting Handrail and Railing Components:** Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

1. Provide concealed fasteners for interconnecting handrail and railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for handrails and railings indicated.

2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. **Cast-in-Place, chemical and Post-installed Anchors:** Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency acceptable to the Engineer.

1. Cast-in-place anchors.

2. Chemical anchors.

3. Expansion anchors.

2.3 GROUT AND ANCHORING CEMENT

A. **Non-shrink, Nonmetallic Grout:** Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

2.4 FABRICATION

A. **General:** Fabricate handrails and railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble handrails and railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Form changes in direction of railing members as follows:

1. As detailed.
2. By bending.
3. By radius bends of radius indicated.
4. By flush radius bends.
5. By mitering at elbow bends.
6. By inserting prefabricated flush-elbow fittings.
7. By any method indicated above, applicable to change in direction involved.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

E. **Welded Connections:** Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections 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 flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

F. **Non-welded Connections:** Fabricate handrails and railings by connecting members with concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive where this is manufacturer's standard splicing method.

G. **Brackets, Flanges, Fittings, and Anchors:** Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.

H. Provide inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.

I. For railing posts set in concrete, provide preset sleeves of steel not less than 150 mm long with inside dimensions not less than 12 mm greater than outside dimensions of post, and steel plate forming bottom closure.

J. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

K. Ease exposed edges to a radius of approximately 1 mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

L. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

M. Provide weep holes or other means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.

N. Fabricate joints that will be exposed to weather in a watertight manner.

O. Close exposed ends of handrail and railing members with prefabricated end fittings.

P. **Toe Boards:** Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

Q. **Fillers:** Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.5 FINISHES, GENERAL

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

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. **Appearance of Finished Work:** Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of handrails and railings.

2.6 STEEL FINISHES

A. General: Unless otherwise indicated on Drawings, pipe and tube railings specified under this Section shall be galvanized and factory painted.

B. **Galvanizing After Fabrication:** Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.

2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

C. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Preparation for Shop Priming: After galvanizing, thoroughly clean handrails and railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.

E. Apply shop primer to prepared surfaces of railings, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.

2. Stripe paint corners, crevices, bolts, welds, and sharp edges.

F. Factory-Applied Finish: Immediately after cleaning and pre-treating, apply manufacturer's standard two-coat, air-dried-enamel or baked-enamel finish consisting of prime coat and top

coat that complies with ANSI A250.3 acceptance criteria. Comply with paint manufacturer's instructions for applying and baking to achieve a minimum dry film thickness of 0.03 mm for topcoat.

1. Color and Gloss: As selected by Engineer from manufacturer's full range.

2. Use air-dried enamel for welded assemblies.

3. Use baked on enamel for mechanical assemblies.

4. Use UV resistant enamel for exterior applications.

5. Use scratch and abrasion resistant enamel for all applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required to install handrails and railings. Set handrails and railings accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

1. Do not weld, cut, or abrade surfaces of handrail and railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 2 mm in 1 m.

3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 5 mm in 3 m.

C. Adjust handrails and railings before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. **Non-welded Connections:** Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of handrails and railings.

B. **Welded Connections:** Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. **Expansion Joints:** Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 50

mm beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 150 mm of post.

3.4 ANCHORING POSTS

A. Unless otherwise indicated on drawings, use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with the following material, mixed and placed to comply with anchoring material manufacturer's written instructions:

1. Non-shrink, nonmetallic grout.

B. Cover anchorage joint with flange of same metal as post, attached to post as follows:

1. By set screws.

C. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 3 mm build-up, sloped away from post.

D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

E. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ANCHORING RAILING ENDS

A. Anchor railing ends into concrete and masonry with round flanges connected to railing ends and anchored into wall construction with post installed anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces.

1. Connect flanges to railing ends using non-welded connections.

3.6 ATTACHING HANDRAILS TO WALLS

A. Attach handrails to wall with wall brackets. Provide brackets with 38-mm clearance from inside face of handrail and finished wall surface.

B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

C. Secure wall brackets to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

2. For hollow masonry anchorage, use toggle bolts.

3. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.

4. For steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

3.7 CLEANING

A. **Touchup Painting:** Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.

B. **Galvanized Surfaces:** Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.8 PROTECTION

A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

SECTION 12 - ORNAMENTAL HANDRAILS AND RAILINGS PART

1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Stainless steel ornamental hand rails and railings.

B. Related Sections include the following:

1. Division 5 Section "Pipe and Tube Railings" for handrails and railings fabricated from pipe and tube components.

2. Division 7 Section “Joint Sealants".

1.3 PERFORMANCE REQUIREMENTS

A. **General:** In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of materials based on the following:

1. Stainless Steel: ASCE 8, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."

B. **Structural Performance of Handrails and Railings:** Provide handrails and railings capable of withstanding structural loads required by ASCE 7 without exceeding allowable design working stress of materials for handrails, railings, anchors, and connections.

C. **Structural Performance of Handrails and Railings:** Provide handrails and railings capable of withstanding the following structural loads without exceeding allowable design working stress of materials for handrails, railings, anchors, and connections:

1. Handrails Not Serving As Top Rails: Capable of withstanding the following loads applied as indicated:

a. Concentrated load of 890 N applied at any point and in any direction.

b. Uniform load of 730 N/m applied in any direction.

c. Concentrated and uniform loads above need not be assumed to act concurrently.

2. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of 890 N applied to 0.09 sq. m at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area.

a. Load above need not be assumed to act concurrently with loads on top

rails in determining stress on guard.

3. Demonstrate capability of proposed handrail systems by:

   a. Submission of structural calculations.

   b. Submission of laboratory test report conducted on the proposed product during the last three years.

D. **Thermal Movements:** Provide handrails and railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 35 deg. C, ambient; 65 deg. C, material surfaces.

E. **Control of Corrosion:** Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

A. **Product Data:**For manufacturer's product lines of handrails and railings assembled from standard components.

1. Include Product Data for grout, anchoring cement, and paint products.

B. **Shop Drawings:** Show fabrication and installation of handrails and railings. Include plans, elevations, sections, details, and attachments to other Work.

1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. **Samples for Initial Selection:** Short sections of railing or flat sheet metal Samples showing available mechanical finishes.

D. **Samples for Verification:** For each type of exposed finish required, prepared on components indicated below and of same thickness and metal indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1. 150 mm long sections of each different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Welded connections.
4. Assembled Samples of railings, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.

E. Samples of exposed fasteners, where exposed fasteners are indicated.

F. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers

and owners, and other information specified.

G. **Product Test Reports:** Indicating products comply with requirements, based on comprehensive testing of current products.

1.5 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

B. **Structural/Consulting Engineer Qualifications:** A structural consulting engineer who is legally qualified to practice, and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of handrails and railings that are similar to those indicated for this Project in material, design, and extent.

C. **Testing Agency Qualifications:** To qualify for acceptance, an independent testing agency shall demonstrate to the Engineer's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.

D. **Source Limitations:** Obtain each type of railing through one source from a single manufacturer.

E. **Mockups:** Before installing handrails and railings, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location as directed by the Engineer.
2. Build mockups for each form and finish of railing consisting of three posts, top rail, infill area, and anchorage system components that are full height and are not less than 600 mm in length.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Notify the Engineer seven days in advance of dates and times when mockups will be constructed.
5. Obtain the Engineer's approval of mockups before fabricating ornamental handrails and railings.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 STORAGE

A. Store handrails and railings in a dry, well-ventilated, weathertight place.

1.7 PROJECT CONDITIONS

A. **Field Measurements:** Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.8 COORDINATION

A. Coordinate installation of anchorages for handrails and railings. 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.

1.9 SCHEDULING

A. Schedule installation so that handrails and railings are mounted only on completed walls. Do not support temporarily by any means that do not satisfy structural performance requirements.

PART 2 – PRODUCTS

2.1 METALS

A. **General:** Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.

Stainless Steel: Grade or type designated below for each form required.

1. ASTM A 554, Grade MT 304.
2. Pipe: ASTM A 312/A 312M, Grade TP 304.
3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20.
4. Plate: ASTM A 666, Type 304.

C. **Brackets, Flanges, and Anchors:** Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.
   1. Provide formed steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.

2.2 MISCELLANEOUS MATERIALS

A. **Filler Metal and Electrodes:** Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as required for color match, strength, corrosion resistance, and compatibility in fabricated items.

2.3 FASTENERS

A. **Fasteners for Anchoring Handrails and Railings to Other Construction:** Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.

   1. For stainless-steel handrails and railings, use fasteners fabricated from Type 304 stainless steel.

B. **Fasteners for Interconnecting Handrail and Railing Components:** Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

   1. Provide concealed fasteners for interconnecting railing components and for attaching them to other Work, unless exposed fasteners are unavoidable or are standard fastening method for handrail and railing indicated.

C. **Cast-in-Place and Postinstalled Anchors:** Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Chemical anchors.

2. Expansion anchors.

2.4 PAINT

A. **Bituminous Paint:** Cold-applied asphalt mastic complying with SSPC-Paint 12 but containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 GROUT AND ANCHORING CEMENT

A. **Nonshrink, Nonmetallic Grout:** Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION

A. General: Fabricate handrails and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacings, and anchorage, but not less than that required to support structural loads.

B. Assemble handrails and railings in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Form changes in direction of railing members as follows:

1. By bending.

2. By flush radius bends.

3. By radius bends of radius indicated.

4. By mitering at elbow bends.

5. By inserting prefabricated flush elbow fittings.

6. By any method indicated above, applicable to change in direction involved.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

E. **Welded Connections:** Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections 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 flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so that no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

F. **Mechanical Connections:** Fabricate handrails and railings by connecting members with railing manufacturer's standard concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using epoxy structural adhesive where this is manufacturer's standard splicing method.

G. **Brackets, Flanges, Fittings, and Anchors:** Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect handrail and railing members to other construction.

H. Provide inserts and other anchorage devices to connect handrails and railings to concrete or masonry. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.

I. For railing posts set in concrete, provide preset sleeves of steel not less than 150 mm long with inside dimensions not less than 13 mm larger than outside dimensions of post, and steel plate forming bottom closure.

1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

J. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

K. Ease exposed edges to a radius of approximately 1 mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

L. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

M. Close exposed ends of railing members with prefabricated end fittings.

N. **Toe Boards:** Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

O. **Fillers:** Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

P. Provide sleeves, inserts, and other anchorage devices to connect handrails and railing systems to concrete, masonry, embedded steel plates, and structural steel work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railing systems. Coordinate anchorage devices with supporting structure.

2.7 FINISHES, GENERAL

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

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. **Appearance of Finished Work:** Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 STAINLESS-STEEL FINISHES

A. Remove or blend tool and die marks and stretch lines into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

B. Coordinate setting drawings, diagrams, templates, instructions, and directions for installing anchorages, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete, masonry, and terrazzo construction. Coordinate delivery of such items to Project site.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. **Cutting, Fitting, and Placement:** Perform cutting, drilling, and fitting required for installing handrails and railings. Set handrails and railings accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 2 mm in 1 m.

3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 5 mm in 3 m.

C. Adjust handrails and railings before anchoring to ensure alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

D. **Fastening to In-Place Construction:** Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

E. Field Welding:

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 smooth and blended so that no roughness or discoloration shows after finishing and welded surface matches contours and finish of adjoining surfaces.

F. **Non-welded Connections:** Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of handrails and railings.

G. **Welded Connections:** Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in shop or in field.

H. **Expansion Joints:** Install expansion joints at locations indicated but not further apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 50 mm beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 150 mm of post.

3.3 ANCHORING POSTS

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions.

1. Nonshrink nonmetallic grout.

B. Form or core-drill holes not less than 125 mm deep and 20 mm greater than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions:

1. Nonshrink, nonmetallic grout.

C. Cover anchorage joint with a flange of same metal as post, attached to post as follows:

1. Welded to post after placing anchoring material.
2. By set screws.
3. Set flange in clear silicone sealant / adhesive flow surface.

D. Leave anchorage joint exposed, wipe off surplus anchoring material, and leave 3 mm build-up, sloped away from post.

E. Anchor posts to metal surfaces with flanges, angle or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   1. For stainless-steel railings, weld flanges to post and bolt to metal supporting members.

F. Where shown on Drawings, fasten posts to face of spandrel construction as indicated and in accordance with manufacturer's instructions.

3.4 ANCHORING RAIL ENDS

A. Anchor rail ends to concrete and masonry with flanges connected to rail ends and anchored with postinstalled anchors and bolts.

3.5 CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.6 PROTECTION

A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit, or provide new units.

SECTION 13 – ROUGH CARPENTRY

PART-1 GENERAL

RELATED WORK

1. Architectural Wood Work

2. Gypsum Board System

1.1 THIS SECTION INCLUDES

This Section specifies incidental rough carpentry required for support or attachment of other construction and not specified in other sections and includes, but is not limited to, the following items:

a. Wood grounds, blockings, nailers.

b. Temporary and permanent grounds, blockings and supports required by other trades.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

a. Wood grounds, nailers, and blocking.

b. Wood furring.

c. Wood sub-frames.

1.3 PRESERVATIVE TREATMENT

a. Application is to be carried out after cutting and machining, but before assembly, by a processor licensed by the treatment solution manufacturer.

b. Solution strengths and treatment by pressure, vacuum or immersion process are to be selected to achieve service life and to suit wood treatability.

c. Moisture content of wood at time of treatment is to be as specified for use in the work.

d. After treatment, allow wood to dry before use.

e. For each batch of wood, provide certificate of assurance that treatment has been carried out as specified.

f. Re-treat all treated wood which is sawn along the length, plouged, thicknessed, planed or otherwise extensively processed.

g. Treat wood surfaces exposed by minor cutting and drilling with two flood coats of solution recommended for the purpose by the treatment solution manufacturer.

1.4 SUBMITTALS

a. Samples of all materials used in the work of this Section.

b. Shop drawings for furring including details, sizes of wood sections, panel, spacings and method of attachment.

1.5 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum.

Incorporate all the standard procedures supplied by the Engineer and the Employer.

1.6 DELIVERY, STORAGE, AND HANDLING

Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.

PART-2 PRODUCTS

TIMBER

a. Timber shall be well seasoned and free from decay, insect attack except pinhole borers, and knots wider than half of the width of the section.

b. Timber shall be kiln dried to a maximum moisture content of 12% by weight.

c. Timber required to be treated with preservatives or fire retardant shall be seasoned and kiln dried before treatment, and re-dried after treatment.

d. Softwood shall be free from decay and insect attack, except pinhole borers, with no knots wider than half the width of the section. Softwood shall comply with BS EN 942 softwood spices to be used in external locations are to be recommended for the purpose.

e. Hardwood shall comply with BS EN 942. Hard wood to be used in internal locations are to be recommended for the purpose.

f. Wood used for exterior applications or for interior applications in wet areas shall be factory treated to prevent moisture absorption.

SOFTWOOD

To be either:

a. Douglas Fir (Standard Grade)

b. European Redwood

c. Or as suggested by the Architect.

HARDWOOD

a. Teakwood

b. White American Oakwood

c. Or as suggested by the Architect.

RIGID SHEETS

2.1 MDF (Fire Resistance)

a. Medium density fiberboard's for fabric panels, 8-10mm thick.

b. Strips of MDF around fabric panels edging.

c. All MDF components to be fire resistant.

2.3 PLY WOOD

a. Plywood: BS EN 636: Part 1, face grade for general use. Bonding is to be to BS 1203, type WBP for external use and type MR or INT for internal use.

b. Marine Quality Plywood: to BS 1088 and BS 4079, excluding plywood made from gaboon.

2.4 CORK BOARD

Are to be preformed sheets that have been formed from clean granulated cork particles securely bound together by a synthetic resin of an insoluble nature. Minimum thickness of sheets is to be 25 mm, width and length are to be as indicated on Drawings.

2.5 FASTENERS

a. Nails: to BS 1202, Part 1, 2 or 3 generally, but non-ferrous types to Parts 2 or 3 for external use.

b. Wood Screws: to BS 1210 generally, but non-ferrous types for external use.

c. Self-Tapping Screws: to BS 4174.

d. Dowels: mild steel, 10 mm diameter, 100 mm long, galvanized to BS EN ISO 1461 after fabrication.

e. Cramps: mild steel, 25 x 3 x 250 mm girth, turned up at one end and twice drilled for 3 mm screws, fish-tailed at other end for building in and galvanized to BS 729 after fabrication.

f. Plugs: either traditional hardwood plugs, shaped to twist and grip when driven, or proprietary fibre or plastics plugs, or other approved type.

2.6 TREATMENTS, ADHESIVES AND FINISHES

a. Preservative Treatment: shall be type listed in BS 1282 (except coal tar creosote), obtained from an approved manufacturer, to give suitable protection against termites and other wood destroying organisms.

b. Adhesive for Joinery: shall be close contact type to BS EN 301 or BS EN 302 suitable for the purpose. Obtain manufacturer's confirmation that adhesive is compatible with preservative treatment.

PART-3 EXECUTION

3.1 INSTALLATION, GENERAL

a. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

b. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.

c. Fit rough carpentry to other construction; scribe and cope as required for accurate fit.Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

d. Apply field treatment to cut surfaces of preservative-treated lumber and plywood.

e. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated.

f. Use common wire nails, unless otherwise indicated. Select fasteners of size that will.not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.

g. Use hot-dip galvanized nails.

h. Countersink nail heads on exposed carpentry work and fill holes with wood filler.

3.2 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

a. Install wood grounds, nailers, blocking, and sleepers where shown and where required for screeding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.

b. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

c. Install permanent grounds of dressed, preservative-treated, key-beveled lumber not less than 1-38 mm wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING

a. Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

b. Firestop furred spaces of walls at each floor level and at ceiling with wood blocking or noncombustible materials, accurately fitted to close furred spaces.

c. Furring to Receive Wood or Plastic Sheets or Boards: Install 19-by-63-mm actual-size furring at 600 mm o.c., horizontally and vertically. Select furring with no knots capable of producing bent-over nails and damage to paneling.

d. Furring to Receive Gypsum Board: Install 19-by-38-mm actual-size furring at 400 mm o.c., vertically.

e. Furring to Receive Plaster Lath: Install 19-by-38-mm actual-size furring at 400 mm o.c., vertically.

SECTION 14 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Pantry cupboard.
2. Laboratory bench.
3. Vanities constructed from solid surfacing.
4. Wood base.

B. Related Sections include the following:

1. Division 6 Section "Rough Carpentry".
2. Division 9 Section "Painting" for field finishing of interior architectural wood works components that need finishing.

1.3 SUBMITTALS

A. **Product Data:** For each type of product indicated, including finishing materials and processes.

1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. **Shop Drawings:** Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show locations and sizes of cutouts and holes for items installed in architectural woodwork.

C. **Samples for Initial Selection:** Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.

1. Shop-applied transparent finishes.
2. Solid-surfacing materials.

D. Samples for Verification: For the following:

1. Wood with or transparent fish, 300 sq.cm, 125 mm wide by 600 mm long finished on one side and 1 edge

2. Solid surfacing material, 150 mm square

3. Pantry Hardware

4. Plastic laminade-clad panel products, 200 by 250mm, for each type, color, pattern and surface finish, with separate samples of unfaced panel product used for cure

E. Signed by suppliers of used woods and rigid sheets certifying that products comply with required

B. **Fabricator Qualifications:** A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. **Source Limitations:** Engage a qualified woodworking firm to assume undivided responsibility for production and installation of interior architectural woodwork.

1.5 PROJECT CONDITIONS

A. **Field Measurements**: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

1.6 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 – PRODUCTS

2.1 WOOD

A. Softwood shall be free from decay and insect attack, except pinhole borers, with no knots wider than half the width of the section. Softwood shall comply with BS EN 942 softwood spieces to be used in external locations are to be recommended for the purpose.

B. Hardwood shall comply with BS EN 942. Hardwood to be used in the works are to be recommended for the purpose.

C. Wood shall be treated to prevent absorption of moisture.

D. Plastic Laminate: to BS EN 438, color and pattern as follows:

1. Color and Pattern: Shall be selected by Engineer from manufacturer's full range of colors and patterns.

2. Minimum Thickness: 1.20 mm.

3. Where indicated, select plastic laminate type suitable for post forming application.

2.2 RIGID SHEETS

A. Plywood: BS EN 636: Part 1, face grade for general use. Bonding is to be to BS 1203, type WBP for external use and type MR or INT for internal use.

2.3 FASTENERS

A. **Nails:** to BS 1202, Part 1, galvanized steel.

B. **Wood Screws:** to BS 1210 generally, galvanized steel.

C. **Self-Tapping Screws:** to BS 4174.

D. **Dowels:** mild steel, 10 mm diameter, 100 mm long, galvanized to BS EN ISO 1461 after fabrication.

E. **Cramps:** mild steel, 25 x 3 x 250 mm girth, turned up at one end and twice drilled for 3 mm screws, fish-tailed at other end for building in and galvanized to BS EN ISO 1461 after fabrication.

F. **Plugs:** either traditional hardwood plugs, shaped to twist and grip when driven, or proprietary fiber or plastics plugs, or other approved type.

2.4 FIRE-RETARDANT-TREATED MATERIALS

A. **General:** Where indicated, use materials impregnated with fire-retardant chemical formulations indicated by a pressure process or other means acceptable to Engineer to produce products with fire-test-response characteristics specified.

1. Do not use treated material that does not comply with requirements of referenced woodworking standard or that is warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.

B. **Fire-Retardant-Treated Lumber and Plywood by Pressure Process:** Comply with BS 5589. Use the following treatment type:

1. Type: Organic-resin-based formulation thermally set in wood by kiln-drying.

2. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

3. Kiln-dry material before and after treatment to levels required for untreated material.

C. All lumber, wood, fir, plywood or boards used in the works of this Section are to be

preservative and fire-retardant treated.

2.5 SOLID SURFACE MATERIAL

A. **Solid-Surfacing Material for Counter Top:** Homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without a precoated finish.

2.6 INSTALLATION MATERIALS, GENERAL

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

2.7 FABRICATION, GENERAL

A. **General:** Comply with requirements of BS 1186-2.

B. **Wood Moisture Content:** Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated.

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Engineer seven days in advance of the dates and times woodwork fabrication will be complete.

2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

G. Fabricated; cabinets and similar items are to be of robust firm neat construction with:

1. Shutters, sashes, drawers and other opening or moving parts working smooth without bound conditions.

2. Clearance between sashes and between jambs and sashes uniform.

3. Level horizontal surfaces and plumb vertical surfaces when installed.

2.8 SHOP PRIMING

A. **General:** Priming of interior architectural woodwork required to be performed at fabrication shop are specified in this Section. Refer to Division 9 Section "Painting" for final finishing of installed architectural woodwork and for priming materials to be used.

B. **Preparations for Priming:** Comply with Division 9, Section "Painting" for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for priming woodwork, as applicable to each unit of work.

1. **Back-priming:** Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to end-grain surfaces.

2.9 PANTRY CUPBOARD AND BENCHES

A. Base counters and upper cabinets units shall be pre-fabricated units constructed to dimensions and details indicated on Drawings.

B. Construct units from the following materials so as to have all exposed or semi-exposed surfaces of plastic laminate finish:

1. 19 mm thick plywood with post-formed plastic laminate finish at both faces for front doors, bottoms and top of upper cabinet and shelves.

2. 19 mm thick solid surfacing material with integral factory formed back splash top of base counter with integral back splash.

3. 6 mm thick plywood of plastic laminate finish at one face for units backs and drawer base.

4. 19 mm thick plywood with post-formed plastic laminate finish for drawers front, sides and back

C. Plastic laminate sheet veneers shall be as specified in Clause 2.1 of this Section, color and pattern to the selection of the Engineer. Units are to be assembled in manufacturer's standard system to provide neat and robust construction.

D. Construct socle of base counter, consisting of perimeter sides and intermediate struts, from hardwood solid blocks and finish exposed fronts to match finish of surrounding floors.

E. Provide metal pre-slotted shelf holders of baked enamel finish complete with removable brackets for shelf supporting. Color is to be to the selection of the Engineer.

F. Provide manufacturer's standard hardware including hinges, drawer slides, latches and knobs of finish to the selection of the Engineer. All hardware shall be manufactured from stainless steel, alloy 304, of satin finish.

G. Blocking wood shall be from approved hardwood type.

H. Construct top of base cabinet units integral with coved back splash from solid surfacing material as specified. Color or colors shall be selected by the Engineer from manufacturer's full range. To the maximum possible extent provide seamless construction. Where seams are unavoidable, align adjacent solid surfacing-material units and factory form seams. Joints are to be dressed smooth with surface scratches removed and entire surface cleaned.

2.10 WOOD BASES

A. Are to be constructed from White Oak hardwood.

B. Fabricate to dimensions and details indicated.

C. Furnish in length as long as practice.

D. Corners are to be mitred at 45 degrees.

E. Finish of bases shall be transparent stained varnish as specified in Division 9, section “Painting”.

2.11 VANITIES

A. Furnish vanities pre-fabricated in the workshop from solid surfacing material. Color(s) shall be selected by the Engineer.

B. Fabricate vanities to dimensions indicated on Drawings and details indicated on approved shop drawings. Comply with the following sheet thickness:

- Vanity: 20.0 mm
- Aprons and backsplash: 13.0 mm.

C. Provide seamless vanity construction with pre-opened holes for assembly of lavatories. Use approved samples of lavatories for fixing size of holes. Comply with manufacturer’s printed instructions for fabrication of vanities.

PART 3 – EXECUTION

3.1 PREPARATION

A. Condition woodwork to average prevailing humidity conditions in installation areas before installation.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. **Quality Standard:** Install woodwork to comply with BS 1186-2 and details indicated on Drawings and approved shop drawings.

B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops).

C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.

D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with recommendations of chemical treatment manufacturer, including those for adhesives used to install woodwork.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for

complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

F. Fix wood bases with pre-drilled, expansion-type wall plugs fabricated from hard nylon and galvanized-steel wood screws of suitable length and diameter at maximum intervals of 750 mm. Counter sink heads of screws in wood and overfill with approved wood filler of matching color as adjacent finished stained wood.

G. Refer to Division 9 Section “Painting” for final finishing of installed architectural woodwork components that need finishing.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean woodwork on exposed and semi exposed surfaces.

SECTION 15 – LIQUID APPLIED WATERPROOFING

PART 1

1.01 RELATED WORK

A. Section 03301 - Concrete.

B. Section 07110 - Membrane Waterproofing for external application

C. Division 15 - Drain flashing flanges.

1.02 WORK INCLUDED

A. Fluid applied cold applied one or two component polyurethane membrane waterproofing. For internal application.

B. Protective covering.

1.03 REFERENCES

A. ANSI/ASTM D412 - Rubber Properties in Tension.

B. ANSI/ASTM D746 - Test for Brittleness Temperature of Plastics and Elastomerics by Impact.

C. ASTM C836 - High Solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane for Use With Separate Wearing Course.

D. ASTM D624 - Rubber Property - Tear Resistance.

E. ASTM D2240 - Rubber Property - Durometer Hardness.

F. ASTM E96 - Water Vapour Transmission of Materials.

1.04 QUALITY ASSURANCE

A. **Membrane Manufacturer:** Company specializing in liquid waterproofing membrane systems with eight years minimum experience.

B. **Applicator:** Company specializing in application of specified waterproofing with five years minimum experience and approved by manufacturer.

1.05 FIELD SAMPLE

A. Provide field sample of installed membrane.

B. Field sample to represent conditions of finished work including internal and external corners, seam jointing, attachment method, sealing and counter

flashing cover, and control and expansion joints.

C. Approved sample may be incorporated as part of the Work.

1.06 SUBMITTALS

A. Submit shop drawings and product data under provisions of General Requirements.

B. Submit shop drawings detailing special joint or termination conditions and conditions of interface with other materials.

C. Submit product data for liquid membrane compound, flexible flashing, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.

D. Submit manufacturer's installation instructions under provisions Contract Documents

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not apply waterproofing during inclement weather or when air substrate temperature is below 5 degrees C.

B. Liquid water proofing should be non toxic

1.08 WARRANTY

A. Provide (10) ten years warranty under provisions of General Conditions of Contract.

B. Warranty includes coverage of materials and installation and resultant damage from failure of installation to resist penetration of moisture.

C. Warranty includes coverage of waterproofing failure to resist penetration of water except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered as structural failure.

PART 2 -PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Carisle Corporation System Liquiseal

B. Chevron USA (Asphalt Div)System C.I.M.

C. Floorlite - Andek System Rooftex

D. Tremco Ltd System Tremproof 60

E. Fosroc Nitoproof 10

F. or approved equal.

Note: The products and manufacturer specified herein are specified for the purpose of establishing minimum quality standards. Products equal to or better than those specified will be considered acceptable. The decision of acceptability shall rest with Engineer/Engineer Representative.

2.02 MATERIAL

A. **General:** Provide liquid applied waterproofing, and other required materials produced by one manufacturer.

B. **Waterproofing Membrane:** Pitch Modified, High Polymer one part Polyurethane Elastomeric Membrane Type. Trowel apply membrane at areas indicated on Drawings to receive "Waterproofing", consisting of a high polymer and polyurethane applied in multiple layers forming a seamless waterproofing membrane to a minimum thickness of 1.5mm.

C. The Physical properties of the membrane must satisfy the following criteria:

1 Specific Gravity : 1.2

2 Solid Contents : 92% minimum

3 Application Temperature : 5 degrees C to 45 degrees C

4 Cure Time : 4 – 6 Hour

5 Store "A" Hardness : 30 degrees C

6 Tensile Strength : 20N/mm

7 Ultimate Elongation : 680%

8 Accelerated Weathering : 12000 Hours. No appreciable deterioration.

D. Sealer (For Substrate): As recommended by manufacturer.

E. Cant Strips: As recommended by manufacturer.

2.03 ACCESSORIES

A. Surface Conditioner: as recommended by membrane manufacturer.

B. Elastic Flashings: 1.2 as recommended by membrane manufacturer.

C. Joint and Crack Sealant: As recommended by membrane manufacturer.

D. Cant: as detailed on drawings.

2.04 PROTECTIVE MATERIALS

A. Protection Board: 3mm thick, asphalt impregnated board manufactured by W.R. Meadows.

B. Tack-free Surfacer: Normal Portland Cement.

C. Separation Sheet: Sheet polyethylene, 0.15 mm thick.

D. PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify surfaces are solid, free of frozen matter, loose particles, cracks, pits, rough projections, and foreign matter detrimental to adhesion and application of waterproofing.

B. Do not apply waterproofing to damp, frozen, dirty, dusty, or deck surfaces unacceptable to manufacturer and applicator.

C. Verify items, which penetrate surfaces to receive waterproofing, are securely installed.

D. Beginning of installation means acceptance of substrate.

3.02 PREPARATION

A. Clean and prepare surfaces to receive waterproofing, in accordance with manufacturer's instructions.

B. Apply mastic to seal penetrations, small cracks, and honeycomb in substrate.

C. Protect adjacent surfaces not designated to receive waterproofing.

D. Apply surface conditioner at a rate recommended by membrane manufacturer.

3.03 APPLICATION

A. Apply membrane in accordance with manufacturer's instructions.

B. Apply and spread membrane to minimum 2mm thickness, averaging 2.5mm in thickness.

C. Continue membrane up vertical surfaces minimum 150mm or as indicated on drawings.

D. Seal items projecting through membrane.

E. Install membrane flashing and seal into membrane.

F. Reinforce membrane over static or moving joints.

3.04 FIELD QUALITY CONTROL

A. On completion of horizontal membrane installation, dam installation in preparation for flood testing.

B. Flood to minimum depth of 30mm. with clean water. After 48 hours, check for leaks.

C. If leaking is found, patch using new waterproofing materials; repeat

flood-test. Repair damage to building.

D. When area is proved watertight, drain water and remove dam

3.05 PROTECTION

A. Immediately after cooling, dust membrane with Portland Cement at rate of approximately 4 kg/10 sq m.

B. Apply protection boards over cured membrane surface. Scribe boards around pipes and projections.

C. Close off area to prevent un-authorized traffic or work over membrane until final concrete topping is applied.

PART 4 – LOCATION OF THE WORKS

1 - In toilets, pantries and preparation areas, below tiling

2 – Below screed at delivery yard area

3 – Below cold rooms flooring in structurally recessed areas.

SECTION 16 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Pressure plate.
2. Strainers.
3. Reglet.
4. Spout.
5. Roof access hatch.

B. Related Sections include the following:

1. Division 7 Section "Sheet Metal Flashing and Trim" for shop- and field-fabricated metal flashing and downspouts, fasciae and miscellaneous sheet metal trim and accessories.

2. Division 7 Section "EPDM Single-Ply Membrane Roofing ".

1.3 SUBMITTALS

A. **Product Data:** For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.

B. **Shop Drawings:** Show fabrication and installation details. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other Work.

C. **Coordination Drawings:** Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.

2. Method of attaching roof accessories to roof or building structure.

3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.

D. Samples of all products covered in this Section.

1.4 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

B. **Installer Qualifications:** A qualified firm specializing in performing the work of this

Section with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Engineers and Employers, and other information specified

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle components so they will not be damaged or deformed.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. **Aluminum Sheets and Plates:** ASTM B 209M for alclad alloy 3005H25 or alloy and temper required to suit forming operations, with mill finish, unless otherwise indicated.

B. **Extruded Aluminum:** ASTM B 221M alloy 6063-T52 or alloy and temper required to suit structural and finish requirements, with mill finish, unless otherwise indicated.

C. **Galvanized Steel Sheet:** ASTM A 653/A 653M with Z275 coating designation; commercial quality, unless otherwise indicated.

1. Structural Quality: Grade 275, where indicated or as required for strength.

D. **Insulation:** Manufacturer's standard rigid or semi rigid glass-fiber board of thickness indicated.

E. **Wood Nailers:** Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 38 mm thick.

F. **Fasteners:** Same metal as metals being fastened, or nonmagnetic stainless steel or other non corrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.

1. Where removing exterior exposed fasteners affords access to building, provide non removable fastener heads.

G. **Gaskets:** Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

H. **Bituminous Coating:** SSPC-Paint 12, solvent-type bituminous mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 0.4-mm dry film thickness per coating.

I. **Mastic Sealant:** Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

J. **Elastomeric Sealant:** Generic type recommended by unit manufacturer that is compatible with joint surfaces; ASTM C 920, Type S, Grade NS, Class 25, and Uses NT, G, A, and, as applicable to joint substrates indicated, O.

2.3 ALUMINUM PRESSURE PLATE

A. Shall be aluminum section, 40 x 3 mm thick. Comply with details indicated.

2.4 ALUMINUM STRAINERS

A. Shall be fabricated from aluminum alloy extruded sections and bars to in welded constructions. Strainers are to be of dimensions and type approved by the Engineer.

2.5 CHANNEL (REGLET)

A. Shall be fabricated from galvanized steel sheets 0.8 mm thick, dovetailed channel

section for casting into concrete, as shown on the Drawings, to receive edges of water proofing membrane and sealant.

2.6 SPOUTS

A. Shall be uPVC pipes, of diameter and details as indicated on Drawings.

2.7 ROOF HATCHES

A. **General:** Fabricate units to withstand 1.9- kPa external and 0.95-kPa internal loading pressure. Frame with minimum 225-mm- high, integral-curb, double-wall construction with 38- mm insulation, formed cants and cap flashing (roofing counterflashing), with welded or sealed mechanical corner joints. Provide double-wall cover (lid) construction with 25-mm- thick insulation core. Provide gasketing and equip with corrosion-resistant or hot-dip galvanized hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.

B. **Type:** Single-leaf personnel access.

1. For Ladder Access: dimensions as indicated on Drawings.

C. **Material:** Galvanized steel sheets.

1. Finish: Prime painted.

2.8 FINISHES, GENERAL

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

2.9 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. **Class I, Clear Anodic Finish:** AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating but 0.025 mm or thicker) complying with AAMA 611.

2.10 GALVANIZED STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces with non petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

B. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply the air-dried primer specified below immediately after cleaning and pre-treating.

1. Shop Primer: Exterior galvanized metal primer per Division 9 Section "Painting."

PART 3 – EXECUTION

3.1 INSTALLATION

A. **General:** Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weather tight. Anchor roof accessories securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures.

B. Install roof accessory items according to indicated on Drawings and approved shop drawings.

C. **Separation:** Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with bituminous coating or providing other permanent separation.

D. **Flange Seals:** Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

E. **Cap Flashing:** Where required as component of accessory, install cap flashing to provide waterproof overlap with roofing or roof flashing (as counter flashing). Seal overlap with thick bead of mastic sealant.

3.2 CLEANING AND PROTECTION

A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

SECTION 17 – CUSTOM STEEL DOOR AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Steel doors.
2. Steel door frames.
3. Fire-rated door and frame assemblies.
4. Fire-rated window assemblies.
5. Louvers in doors. Steel louvered door.

B. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for building anchors into and grouting frames in masonry construction.
2. Division 8 Section "Door Hardware" for door hardware and weather stripping.
3. Division 8 Section "Glazing" for glass in doors.

1.3 PERFORMANCE REQUIREMENTS

A. **Fire-Rated Door Assemblies:** Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to the Consultant, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure.
2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
3. Temperature-Rise Rating: If indicated, provide doors that have a temperature-rise rating of 250 deg C maximum in 30 minutes of fire exposure.

B. **Fire Resisting Door Components:** All components of fire resisting doors and assemblies, including but not limited to: door leaves, frames, ironmongery, hardware and glazing, shall carry identifying labels of an approved independent testing and inspection agency or laboratory, confirming their individual fire resistance rating. The rating of all door components shall be equal to the rating of the door assembly.

C. **Fire Resisting Door Closers:** All fire resisting doors shall be fitted with door closers that automatically close and positively latch the door. In case of double-leaf

doors, the closing system shall ensure that the inactive door leaf (door leaf with strike) closes first prior to active door leaf (door leaf with lock).

D. Fire rated door assemblies that are tested and certified according to British Standard Specifications (BS) shall also be accepted.

E. Weather Stripping: provide weather seals to all external doors.

F Smoke-Control Door Assemblies: Comply with NFPA 105.

1.4 SUBMITTALS

A. **Product Data**: Include construction details, material descriptions, core descriptions, label compliance, sound and fire-resistance ratings, and finishes for each type of door and frame specified.

B. **Shop Drawings**: Show fabrication and installation of doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, dimensions of profiles and hardware preparation, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessories.

C. **Door Schedule**: Submit schedule of doors and frames using same reference numbers for details and openings as those on Drawings.

1. Coordinate glazing frames and stops with glass and glazing requirements.

D. **Samples for Initial Selection**: Manufacturer's color charts showing the full range of finishes or colors available for units with factory-applied color finishes.

E. **Samples for Verification**: For each type of exposed finish required, prepared on Samples not less than 75 by 125 mm and of same thickness and material indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

F. **Construction Samples**: Approximately 300 by 300 mm, representing the required construction of doors and frames for Project.

1. Doors: Show vertical-edge, top, and bottom construction; insulation; face stiffeners; and hinge and other applied hardware reinforcement. Include louver section and glazing stops if applicable.

2. Frames: Show profile, welded corner joint, welded hinge reinforcement, dust-cover boxes, floor and wall anchors, stops, and silencers. Include panel and louver sections and glazing stops if applicable.

G. **Product Certificates**: Signed by manufacturers of doors certifying that products furnished comply with or exceed the acceptance criteria of ANSI A250.4 for Level A doors.

H. **Oversize Construction Certification**: For door assemblies required to be fire rated and exceeding limitations of labeled assemblies, submit certification of a testing agency acceptable to authorities having jurisdiction that each door and frame assembly has been constructed to comply with design, materials, and construction equivalent to requirements for labeled construction.

1.5 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Manufacturer Qualifications:** A firm experienced in manufacturing custom steel doors and frames similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. **Mockups:** Before installing custom steel doors and frames, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location indicated or, if not indicated, as directed by Consultant.

2. Build mockups for each custom steel doors and frames, and anchorage system components.

3. Notify Consultant seven days in advance of dates and times when mockups will be constructed.

4. Obtain Consultant's approval of mockups before fabricating custom steel doors and frames.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 WARRANTY

A. **Door Manufacturer's Warranty:** Provide written Warranty, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that do not fulfill quality and performance requirements or do not comply with tolerances in referenced quality standard such as, but not limited to:

1. Structural failures.

2. Faulty operation of movable parts and hardware.

3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

B. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

1. Warranty Period: Three years from date of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palleted, wrapped, or crated to provide protection during transit and Project site storage. Do not use nonvented plastic.

B. Inspect doors and frames, on delivery, for damage. Minor damage may be repaired provided refinished items match new work and are approved by Consultant;

otherwise, remove and replace damaged items as directed.

C. Store doors and frames under cover at building site. Place units on minimum 100-mm- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If wrappers on doors become wet, remove cartons immediately. Provide minimum 6-mm spaces between stacked doors to permit air circulation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. **Metallic-Coated Steel Sheets:** ASTM A 653/A 653M, CS (commercial steel), Type B; with Z180 zinc (galvanized) or ZF180 zinc-iron-alloy (galvannealed) coating.

B. **Inserts, Bolts, and Fasteners:** Manufacturer's standard units. Where items are to be built into exterior walls, zinc coat according to ASTM A 153/A 153M, Class C or D as applicable.

2.2 DOORS

A. **General:** Provide flush-design doors, minimum 44 mm thick, of seamless construction, unless otherwise indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges.

1. Visible joints or seams around glazed or louvered panel inserts are permitted.

2. For single-acting swing doors, bevel both vertical edges 3 mm in 50 mm.

3. For double-acting swing doors, round vertical edges with 54-mm radius.

B. **Metallic Core Construction:** Provide the following core construction welded to both door faces:

1. Steel-Stiffened Core: Galvanized steel vertical stiffeners extending full-door height, spaced not more than 150 mm apart and spot welded to face sheets a maximum of 150 mm o.c. Fill spaces between stiffeners with rockwool insulation of minimum 96.00 kg/cu. m density applied to inside surfaces of face sheets.

2. Use for all doors internal and external.

3. Thickness of vertical stiffeners shall be equal to or more than thickness of door skins

C. **Fire Door Cores:** As required to provide fire-protection and temperature-rise ratings indicated.

D. **Astragals:** As required by NFPA 80 to provide fire ratings indicated. Comply with requirements specified in Division 8, section “Hardware”

E. **Top and Bottom Channels:** Spot weld metal channel not less than thickness of face sheet to face sheets not more than 150 mm o.c.

1. Reinforce tops and bottoms of doors with inverted horizontal channels of same material as face sheet so flanges of channels are even with bottom and top edges of face sheets.

2. For exterior doors, close bottom edge with metallic-coated steel closing channel and top edge with filler channel of same material, so webs of channels are flush with bottom and top door edges.

F. **Hardware Reinforcement:** Fabricate reinforcing plates from the same material as door to comply with the following:

1. Hinges and Pivots: 4.2 mm thick by 38 mm wide by 150 mm longer than hinge, secured by not less than 6 spot welds.

2. Lock Face, Flush Bolts, Closers, and Concealed Holders: 2.3 mm thick.

3. All Other Surface-Mounted Hardware: 1.3 mm thick.

G. **Interior Doors:** Fabricate face sheets of doors from two 1.30-mm- thick metallic-coated, cold-rolled, stretcher-leveled steel sheets and other metal components from hot- or cold-rolled steel sheets.

H. Thickness of face sheets for fire rated interior doors shall be as recommended by manufacturer to obtain fire rating indicated, but not less than 1.30 mm.

I. Thickness of face sheets for interior steel doors to receive armor plates shall be 1.60 mm.

J. **Exterior Steel Doors:** Fabricate face sheets of doors from two 1.6-mm- thick, stretcher-leveled, metallic-coated steel sheets. Provide weep-hole openings in bottom of doors to permit entrapped moisture to escape. Seal joints in top edges of doors against water penetration.

2.3 FRAMES

A. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, and continuously welded full depth and width of frame. Knockdown frames are not acceptable.

1. For exterior use, form frames from 2.00-mm- thick, metallic-coated cold-rolled steel sheets.

2. For interior use, form frames from metallic-coated cold-rolled steel sheet of the following thicknesses:

a. Openings up to and Including 1200 mm Wide: 1.60 mm.

b. Openings More Than 1200 mm Wide: 1.7 mm.

B. **Hardware Reinforcement:** Fabricate from same material as frame. Minimum thickness of steel reinforcing plates for the following hardware:

1. Hinges and Pivots: 4.2 mm thick by 38 mm wide by 150 mm longer than hinge, secured by not less than 6 spot welds.

2. Strikes, Flush Bolts, and Closers: 2.3 mm.

3. Surface-Mounted Hold-Open Arms and Panic Devices: 2.3 mm.

C. **Mullions and Transom Bars:** Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.

1. Provide false head member to receive lower ceiling where frames extend to finish ceilings of different heights.

D. **Head Reinforcement:** Where installed in masonry, leave vertical mullions in frames open at top for grouting.

E. **Jamb Anchors:** Weld jamb anchors to frames near hinges and directly opposite on strike jamb as required to secure frames to adjacent construction.

1. In-Place Concrete or Masonry: Anchor frame jambs with minimum 9-mm-diameter concealed bolts into expansion shields or inserts 150 mm from top and bottom and 650 mm o.c., unless otherwise indicated. Reinforce frames at anchor locations. Except for fire-rated openings, apply removable stop to cover anchor bolts, unless otherwise indicated.

F. **Floor Anchors:** Provide floor anchors for each jamb and mullion that extends to floor, formed of same material as frame, 1.7 mm thick, as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.

2. Cement-Based Screeds: Adjustable type with extension clips, allowing not less than 50-mm height adjustment. Terminate bottom of frames at finish floor surface.

G. **Head Anchors:** Provide 2 head anchors for frames more than 1066 mm wide and mounted in steel-stud walls.

H. **Head Strut Supports:** Provide 9-by-50-mm vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.

I. **Structural Reinforcing Members:** Provide as part of frame assembly, where indicated at mullions, transoms, or other locations to be built into frame.

J. **Head Reinforcement:** For frames more than 1200 mm wide in masonry wall openings, provide continuous steel channel or angle stiffener, 2.3 mm thick for full width of opening, welded to back of frame at head.

K. **Spreader Bars:** Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.

L. **Rubber Door Silencers:** Except on weather-stripped doors, drill stop in strike jamb to receive three silencers on single-door frames and drill head jamb stop to receive two silencers on double-door frames. Install plastic plugs to keep holes clear during construction. Silencers shall be neoprene, UL-rated for fire doors.

M. **Plaster Guards:** Provide 0.4-mm- thick plaster guards or dust-cover boxes of same material as frame, welded to frame at back of hardware cutouts to close off interior of openings and prevent mortar or other materials from obstructing hardware operation.

N. External frames shall have continuous grooves along perimeter to house weather stripping.

2.4 LOUVERS

A. **Door Louvers:** Fabricate louvers and mount flush into doors without overlapping

moldings on surface of door face sheets. Provide internal support as recommended by louver manufacturer. Prime paint steel louvers after fabrication.

1. Interior Louvers: Sightproof, stationary type, constructed of inverted Y-shaped blades formed of same material as door.

    a. Steel: 1.00 mm thick.

B. **Fire-Rated Automatic Louvers:** Sight proof louver inserts fabricated from 1.3-mm-thick steel, spring operated, and released by 57 deg C fusible links listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by the same testing and inspecting agency that established fire-resistance rating of door assembly.

2.5 STOPS AND MOLDINGS

A. Provide stops and moldings around solid, glazed, and louvered panels where indicated.

B. Form fixed stops and moldings integral with frame, unless otherwise indicated.

C. Provide removable stops and moldings where indicated or required, formed of 0.8-mm- thick steel sheets matching steel frames. Secure with countersunk flat or oval head machine screws spaced uniformly not more than 300 mm o.c. Form corners with butted hairline joints.

D. Coordinate rabbet width between fixed and removable stops with type of glass or panel and type of installation indicated.

2.6 FABRICATION

A. Fabricate doors and frames rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

1. Fabricate doors to comply with acceptance criteria of ANSI A250.4 for a Level A door.

B. For doors with metallic core construction, weld cores to both door face sheets.

C. For doors with nonmetallic core construction, laminate core material to both door face sheets with waterproof adhesive.

D. **Exposed Fasteners:** Provide countersunk flat or oval heads for exposed screws and bolts, unless otherwise indicated.

E. **Thermal-Rated (Insulating) Assemblies:** At exterior locations and elsewhere as shown or scheduled, provide doors and frames fabricated as thermal-insulating assemblies and tested according to ASTM C 236 or ASTM C 976.

1. Provide thermal-rated assemblies with U-factor matching that of the assembly involving door.

F. **Hardware Preparation:** Prepare doors and frames to receive hardware, including cutouts, reinforcement, mortising, drilling, and tapping, according to final hardware

schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series specifications for door and frame preparation for hardware.

1. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

2. Locate hardware as indicated or, if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

G. **Electrical Closets Doors:** Are to comply with the following requirements:

1. Doors are to be proprietary, labeled as one (1) hour fire resistance rated and complying with requirements specified in this Section.

2. Frames are to be integral with sill to be anchored to underlying sill construction.

2.7 STEEL LOUVERED DOOR:

A. General: Are to heavy-duty construction, stile-and-rail door leaves with prefabricated framed steel louver panels mechanically fixed flush with stiles and rail of the door leaves.

1. Stiles and rails are to of tubular construction with sound deadening core material. Stiles and top rail are to be 75 mm wide, bottom rail 250 mm high, unless otherwise indicated on Drawings.
2. Stiles and rails are to be from galvanized sheet steel as specified, 1.30 mm thick minimum. Reinforcement for hinge installation is to be minimum 4.00 thick galvanized steel plates. Drilling and tapping for surface applied ironmongery may be done on Project Site.

3. Louver panels are to be pre-fabricated panels from galvanized steel sheets as specified in this Section comprising tubular frame and fixed Z-shaped, blades, 1.60 mm thick minimum, in welded construction. Free area shall not be less than 43%.

4. Furnish doors with louver panels pre-assembled and finished with factory applied baked enamel system including corrosion inhibiting protective coating and baked-on polyester topcoat of minimum dry film thickness of 60 microns. Color is to be selected by the Consultant.

5. Louver panel fasteners are to be galvanized steel of matching finish.

2.8 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for cleaning, treating, priming, and when specified, finishing.

B. Finish products specified in this Section after fabrication.

2.9 METALLIC-COATED STEEL FINISHES

A. **Surface Preparation:** Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply

with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

B. **Factory-Applied Finish:** Immediately after cleaning and pre-treating, apply manufacturer's standard two-coat, air-dried-enamel, baked-enamel, or polyester finish consisting of prime coat and topcoat that complies with ANSI A250.3 acceptance criteria. Comply with paint manufacturer's instructions for applying and baking to achieve a minimum dry film thickness of 0.03 mm for topcoat.

1. Color and Gloss: As selected by Consultant from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. **General:** Install doors and frames according to DHI A115.IG and manufacturer's written instructions.

B. **Frames:** Install steel frames for doors, transoms, sidelights, borrowed lights, and other openings, of size and profile indicated.

1. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
2. Install frames with removable glazing stops located on secure side of opening.
3. Install door silencers in frames before grouting.
4. Remove temporary braces necessary for installation only after frames have been properly set and secured.
5. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
6. Apply bituminous coating to backs of frames that are filled with mortar, grout, and plaster containing anti-freezing agents.
7. Set masonry anchorage devices where required for securing frames to in-place concrete or masonry construction.
    a. Set anchorage devices opposite each anchor location according to details on Shop Drawings and anchorage device manufacturer's written instructions. Leave drilled holes rough, not reamed, and free of dust and debris.
8. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on Shop Drawings.
9. Placing Frames: Set frames accurately in position; plumb; align, and brace securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
    a. At existing concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.
    b. At fire-rated openings, install frames according to NFPA 80.
    c. Field splice only at approved locations. Weld, grind, and finish as

required to conceal evidence of splicing on exposed faces.

d. Remove spreader bars from each frame only after frame is properly set and secured.

10. Hollow core of frames shall be fully filled with cement sand grout.

11. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.

12. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar as specified in Division 4 Section "Unit Masonry Assemblies."

13. Concrete Walls: Solidly fill space between frames and concrete with grout. Install grout in lifts and take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

14. In-Place Concrete or Masonry Construction: Secure frames in place with post installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

15. In-Place Gypsum Board Partitions: Secure frames in place with post installed expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

16. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.

C. **Doors:** Fit non-fire-rated doors accurately in their respective frames, with the following clearances:

1. Jambs and Head: 2 mm.

2. Meeting Edges, Pairs of Doors: 3 mm.

3. Bottom: 9 mm, if no threshold or carpet.

4. Bottom: 3 mm, at threshold or carpet.

D. **Fire-Rated Doors:** Install with clearances as specified in NFPA 80.

E. **Smoke Control Doors:** Install according to NFPA 105.

3.2 ADJUSTING AND CLEANING

A. **Final Adjustments:** Check and readjust operating hardware items just before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.

B. **Factory-Finish Touchup:** Immediately after erection, sand to feather-edge minor scratched, chipped, or damaged areas and apply touchup of compatible air-drying paint. Minor finish imperfections may be repaired provided finish matches new work finish and is approved by Consultant; otherwise, remove and replace.

SECTION 18 WOODEN DOORS

PART 1 - GENERAL SECTION

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Non-fire-rated flush wood doors of semi-solid core.
2. Shop priming flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.
4. Louvers for flush wood doors.

B. Related Sections include the following:

1. Division 8 Section “Steel Doors and Frames” for steel frames to receive flush wood doors.
2. Division 8 Section "Door Hardware" hardware for flush wood doors.
3. Division 8 Section "Glazing" for glass view panels in flush wood doors.
4. Division 9 Section "Painting".

1.3 SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction, trim for openings, and louvers.

1. Include factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of mortises and holes for hardware.
2. Indicate dimensions and locations of cutouts.
3. Indicate doors to be factory finished and finish requirements.

C. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:

1. Faces of factory-finished doors with opaque finish. Show the full range of colors available.

D. Samples for Verification: As follows:

1. Corner sections of doors approximately 200 by 250 mm with door faces and

edgings representing the typical range of color and grain for each species of veneer and solid lumber required. Finish sample with same materials proposed for factory-finished doors.

2. Louver blade and frame sections, 150 mm long, for each material and finish specified.

3. Frames for light openings, 150 mm long, for each material, type, and finish required.

1.4 QUALITY ASSURANCE

A. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.

1. Individually package doors in plastic bags or cardboard cartons.

2. Individually package doors in cardboard cartons and wrap bundles of doors in plastic sheeting.

B. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with requirements of the referenced quality standard for Project's geographical location.

1.7 WARRANTY

A. Door Manufacturer's Warranty: Provide written Warranty, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 6.5 mm in a 1100-by-2100-mm section or that show telegraphing of core construction in face veneers exceeding 0.25 mm in a 75-mm span, or do not comply with tolerances in referenced quality standard.

1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

2. Warranty shall be in effect during the following period of time after the date of Substantial Completion:

a. Semi-solid-core Interior Doors: Two years.

PART 2 - PRODUCTS

2.1 WOODS, GENERAL

A. Woods shall be marked-on as Class-1 stocks which shall be properly treated, adequately seasoned and free from roy or insect attack, splits, shakes or checks, warping, twisting, chipping, loose knots and waming. Provide woods of wane-free edges. Woods shall conform to the requirements of BS EN No. 942; plywood to BS EN No. 636.

B. **Preservative Treatment:** All woods and plywood used shall be preservative treated. Application is to be carried out after cutting and machining, but before assembly, by a processor licensed by the treatment solution manufacturer. Solution strengths and treatment by pressure, vacuum or immersion process are to be selected to achieve service life and to suit wood treatability. Moisture content of wood at time of treatment is to be as specified for use in the work. After treatment, allow wood to dry before use. For each batch of wood, provide certificate of assurance that treatment has been carried out as specified.

C. Softwoods

1. Douglas Fir: Yellowish Brown wood of average intensity not less than 570 kg/m3 at 12% moisture content.

2. Whitewood: White/pale Yellowish Brown wood of average intensity of 470 kg/m3.

3. Or as directed by the Architect.

D. Hardwoods

1. White Oak Wood: Yellowish Brown, fine-grained wood of strong, compact, homogenous fibers and uniform texture. Average intensity shall not be less than 720 kg/m3 at 12% moisture content. Or as directed by the Architect.

E. Plywood

1. General: Shall be highest grade to BS EN 636, designated as veneer, with minimal imperfections as peeled. Moisture content shall not exceed 12%. Thickness shall be as specified. Employ plywood glued with INT glues to BS 1203.

2. Softwood Plywood: All layers shall be of softwood.

3. Hardwood Plywood: White Oak plywood; White-Oak veneer 0.90 mm thick minimum shall be factory hot-applied at exposed face of door, cut and match of veneer shall be selected by the Consultant.

2.2 ACCESSORY MATERIALS

A. Preservative treatment: Type listed in BS 1282 (except coal tar creosote) obtained from approved manufacturer to provide protection against termites and other destroying organisms.

B. Adhesives: Close contact type to BS EN 301 or BS EN 302, suitable for the purpose and compatible with preservative treatment.

2.3 NON-FIRE RATED SEMI-SOLID-CORE FLUSH WOOD DOORS

A. **General:** Non-fire-rated flush wood doors shall be swinging-type side-hinged to jambs of frames with hand of doors as indicated on Drawings, fabricated to the general tolerances of BS No. 4787 and shall consist of a frame (door leaf frame) consisting of stiles and rails constructed of Douglas fir and a core constructed of a lower-density softwood (Whitewood). Core strips shall cover, at least, 67% of door leaf area (Semi-solid core).

B. **Door Leaf Frame:** Stiles and rails shall be of dimensions as indicated on Drawings but in no case shall the width be less than 140 mm for mortise stile or less than 100 mm for other stile and rails, before lipping. Door-leaf-frame components shall be continuously lipped at outer edges with 20 mm thick lipping constructed of White Oak wood. Oak lipping shall be fixed to stiles and rails in continuous glued tongue-and-groove joints. Stiles, rails and lipping of door leaf frame shall be constructed in one piece, no jointing or splicing shall be permissible. Joints between stiles and rails shall be glued mortise-and-tenon.

C. **Semi-Solid Cores:** Shall be horizontal rails of White wood, of uniform width. Ratio of solid to vacant shall be 2:1. Horizontal core rails shall be in one pieces. Throughout door leaf height, at least, two horizontal core rails shall be mortise-and-tenon jointed and glued to stiles.

D. **Facing:** Facing material shall be 6 mm thick plywood glued with waterproof glue under pressure to both sides of core. Facing material shall extend flush and uniform, in both directions, between inner edges of lipping. Extend facing in one piece; no jointing or splicing shall be permissible. Type of facing material shall be as follows:

1. Doors of Opaque Finish: Softwood plywood

E. **Thickness of Doors:** Unless otherwise indicated on Drawings, finish thickness of flush non-fire-rated wood doors shall be 45 mm; thickness of stiles, rails and core strips shall be 33 mm and 45 mm wood lipping.

2.4 LOUVERS AND LIGHT FRAMES

A. Metal Louvers: As follows:

1. Blade Type: Vision proof, inverted V.

2. Metal and Finish: Extruded aluminum with clear anodic finish, 25micron thick minimum.

2.5 HARDWARE

A. Hardware shall be as indicated in Hardware Sets and Door Schedule and as specified in Division 8, Section "Door Hardware".

2.6 FABRICATION, GENERALLY

A. Flush wood doors shall be fabricated in accordance with details shown on Drawings, requirements of this Section, general tolerances of BS No. 4787 and other in-contradicting requirements of BS No. 1186: Part 2.

B. Carefully plan and layout the work to erect wood doors and to accommodate the work of other trades.

C. Finish wood shall be smoothly dressed and sanded prior to assembly of door inner frames and shall be free from open joints, hammer and machine marks and other defects or surface blemishes.

D. Re-treat all treated wood which is sawn along the length, ploughed, thickness, planed or otherwise extensively processed. Treat wood surfaces exposed by minor cutting and drilling with two flood coats of solution recommended for the purpose by the treatment solution manufacturer.

E. Finish and cut wood at exact dimensions as required. Stile and rails shall be connected only in glued mortise-and tenon joints with horizontal core strips assembled and jointed at their locations between rails, along stiles. The resulting frame shall be robust, firm and square.

F. Facing material shall be glued to core and frame. No nail-fixing exposed or concealed, for facing material shall be permissible. The assembly shall be glued under pressure with waterproof casein glue and be thoroughly dried and seasoned.

G. Join lipping at outer perimeter of frame in continuous tongue-and-groove joints with glue.

H. Factory machine doors for hardware that is not surface applied. Locate hardware as indicated on approved shop drawings. Comply with final hardware schedules, door frame shop drawings, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

I. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.

1. Light Openings: Trim openings with moldings of material and profile indicated.

2. Louvers: Factory install louvers in prepared openings.

2.7 SHOP PRIMING

A. Doors for Opaque Finish: Shop seal faces and edge of doors including cutouts with one coat of wood primer specified in Division 9 Section "Painting."

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.

2. Reject doors/ frames with defects.

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

3.2 INSTALLATION

A. Hardware: For installation, see Division 8 Section "Door Hardware."

B. Manufacturer's Written Instructions: Install wood doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.

C. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as

indicated below; do not trim stiles and rails in excess of limits set by manufacturer. Machine doors for hardware. Seal cut surfaces after fitting and machining.

1. Clearances: Provide 3.2 mm at heads, jambs, and between pairs of doors. Provide 3.2 mm from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 6.4 mm from bottom of door to top of threshold.

2. Bevel non-fire-rated doors 3-1/2 degrees at lock and hinge edges.

D. Field-Finished Doors: Refer to the following for finishing requirements:

1. Division 9 Section "Painting."

3.3 ADJUSTING AND PROTECTING

A. Operation: Re-hang or replace doors that do not swing or operate freely.

B. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Substantial Completion by the Employer.

SECTION 19 – ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Wall access doors and frames.
2. Recessed panels for ceramic tiles.
3. Access panels for suspended gypsum board ceilings.
4. Wood shaft access doors.

B. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for anchoring access door frames set in masonry, construction and grouting
2. Division 6, Section "Rough Carpentry" for materials and workmanship requirements for wooden shaft access doors.
3. Division 9 Section "Gypsum Board Assemblies" for access panels to be installed in suspended gypsum board ceilings.
4. Division 9 Section "Ceramic Tiles" for ceramic tiles and adhesives.
5. Division 9 Section "Painting".
6. Division 15 Section "Duct Accessories" for heating and air-conditioning duct access doors.

1.3 SUBMITTALS

A. **Product Data:** For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.

B. **Shop Drawings:** Show fabrication and installation details of doors and frames. Include plans, elevations, sections, details, and attachments to other Work.

C. **Samples:** For each door face material, at least 75 by 125 mm in size, in specified finish.

1.4 QUALITY ASSURANCE

A. **Source Limitations:** Obtain each type of doors and frames through one source from a single manufacturer.

B. **Fire-Rated Access Doors and Frames:** Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are labeled and listed by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 for vertical access doors.

C. **Size Variations:** Obtain Engineer's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.5 COORDINATION

A. **Verification:** Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS),Type B, with ZF180 zinc-iron-alloy (galvannealed) coating or Z180 mill-phosphatized zinc coating; stretcher-leveled standard of flatness; with minimumthickness indicated representing specified thickness according to ASTM A 924/A 924M.

C. **Plaster Bead:** Casing bead formed from 0.75-mm zinc-coated steel sheet with flange formed out of expanded metal lath and in size to suit thickness of plaster.

2.2 PAINT

A. **Shop Primers:** Provide primers that comply with Division 9 Section "Painting."

B. **Shop Primer for Metallic-Coated Steel:** Organic zinc-rich primer complying with SSPC-Paint 20 and compatible with topcoat.

C. **Galvanizing Repair Paint:** High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

2.3 ACCESS DOORS AND FRAMES

A. Flush, Insulated, Fire-Rated Access Doors and Trimless Frames: Fabricated from metallic-coated steel sheet.

1. Locations: wall surfaces.

2. Fire-Resistance Rating: As indicated on Drawings.

3. Temperature Rise Rating: 139 deg C at the end of 30 minutes.

4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 1.5 mm.
5. Frame: Minimum 1.5-mm thick sheet metal with plaster bead.

6. Hinges: Concealed pin type.

7. Lock: Key-operated cylinder lock, specified in Division 8 Section “Door Hardware”.

B. **Recessed Panels for Ceramic tiles:** Units consisting of frame with expansion casing bead, door, hardware and complying with the following requirements:

1. Frame: Zinc-coated steel sections and shapes.

2. Plaster casing Bead: 0.76 mm zinc coated steel casing bead with flange formed out of expanded metal lath.

3. Panel: 2 mm zinc coated steel sheet.

4. Finish: Ceramic wall tiles matching adjacent walls adhered with water cleanable epoxy-based adhesive.

5. Hardware: Nickel-plated steel hinges, exposed type and self-latching bolt operated with knurled knob.

C. **Heavy Duty Gypsum Board Ceiling Panels:** Heavy duty ceiling flush access panel with fully concealed steel frame and gypsum board inlay fastened to door.

1. Material: Removable spring-loaded door, integrated safety catches, patented concealed nylon hinge mechanism, rounded or square corners as directed, formed galvanized frames, stainless steel springs, zinc-plated fasteners, self-adhesive rubber gasket and accessories. Frame shall be two-part type fixed to opening edges and recessed door gypsum board inlay.

2. Latch: Tamper-resistant cam latch.

3. Sizes: As indicated on Drawings.

4. Models: Suitable for flush installation in ceiling constructed from 12.5, 12.7, 15.00 or 15.9 mm.

2.4 SHAFT ACCESS DOOR

A. **Doors:** Solid core from approved softwood. 3 mm thick plywood facing and hardwood lipping.

B. **Frame:** Fabricate from preservative treated hardwood. Joints between stile and rail shall be single dove tail joints. Protect frame surfaces in contact with masonry with approved bitumen-based cold-applied protection coating.

C. **Anchors:** Type suitable for fixing into concrete or hollow concrete masonry with metal components fabricated from corrosion-resistant material. Use minimum two anchors per each frame jamb or sill.

D. **General:** Comply with requirements of Sections “Rough Carpentry” and “Flush Wood Doors” for preservative treatment and general workmanship requirements

E. **Finishing:** Field-applied approved paint type of color selected by Engineer.

2.5 FABRICATION

A. **General:** Provide access door assemblies manufactured as integral units ready for installation.

B. **Metal Surfaces:** For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. **Steel Doors and Frames:** Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.

1. For trimless frames with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.

D. **Latching Mechanisms:** Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder lock, furnish two keys per lock and key all locks alike.

2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

2.6 FINISHES, GENERAL

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.

2.7 METALLIC-COATED STEEL FINISHES

A. **Galvanizing of Steel Shapes and Plates:** Hot-dip galvanize items indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.

2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

B. **Surface Preparation:** Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. For galvanized surfaces, apply, after cleaning, a conversion coating suited to the organic coating to be applied over it. For metallic-coated surfaces, clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. **Galvanizing Repair Paint:** High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.

C. Factory Priming for Field-Painted Finish: Apply shop primer immediately after cleaning and pre-treating.

PART 3 – EXECUTION

3.1 PREPARATION

A. Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.

C. Install access doors with trimless frames flush with adjacent finish surfaces or

recessed to receive finish material.

D. Installation of fire-rated access doors and panels shall maintain same applicable requirements of Standards referenced for installation of fire-rated steel frames in Division 8, Section "Custom Steel Doors and Frames".

3.3 ADJUSTING AND CLEANING

A. Adjust doors and hardware after installation for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

SECTION 20 – ALUMINUM FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior manual-swing aluminum doors.

B. Related Sections include the following:

1. Division 7 Section "Joint Sealants" for installation of joint sealants installed with aluminum-framed systems and for sealants to the extent not specified in this Section.

2. Division 8 Section "Sliding Automatic Entrances Doors".

3. Division 8 Section "Door Hardware" for lock cylinders and closers.

4. Division 8 Section "Glazing" for glazing requirements to the extent not specified in this Section.

5. Division 8 Section “Structural Glazed Aluminum Curtain Wall”.

1.3 PERFORMANCE REQUIREMENTS

A. **General:** Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:

1. Structural loads.

2. Thermal movements.

3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.

4. Dimensional tolerances of building frame and other adjacent construction.

5. Failure includes the following:

a. Deflection exceeding specified limits.

b. Thermal stresses transferred to building structure.

c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.

d. Glazing-to-glazing contact.

e. Noise or vibration created by wind and thermal and structural movements.

f. Loosening or weakening of fasteners, attachments, and other components.

g. Sealant failure.

h. Failure of operating units to function properly.

B. Structural Loads:

1. Wind Loads: Uniform Building Code (UBC) 1997 Edition, Exposure C, Basic Wind Speed 130 km/hr.

2. Seismic Loads: Provide aluminum systems, including anchorage, capable of withstanding the effects of earthquake motions calculated according to requirements of Uniform Building Code (UBC), 1997 Edition, Zone 2A.

C. Deflection of Framing Members:

1. **Deflection Normal to Wall Plane:** Limited to 1/175 of clear span for spans up to 4.1 m and to 1/240 of clear span plus 6.35 mm for spans greater than 4.1 m.

2. **Deflection Parallel to Glazing Plane:** Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below to less than 3.2 mm and clearance between members and operable units directly below to less than 1.5 mm.

D. **Structural-Test Performance:** Provide aluminum systems tested according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.

2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.

3. Test Durations: As required by design wind velocity but not less than 10 seconds.

E. **Thermal Movements:** Provide exterior aluminum systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base Consultanting calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. **Temperature Change (Range):** 35 deg C, ambient; 65 deg C, material surfaces.

2. **Test Performance:** No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

a. Test Ambient Temperature Range: plus 15 to 55 deg. C.

F. **Air Infiltration:** Provide exterior aluminum systems with maximum air leakage through fixed glazing and framing areas of 0.03 L/s per sq. m of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 300 Pa.

G. **Water Penetration Under Static Pressure:** Provide exterior aluminum systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 300 Pa.

H. **Water Penetration Under Dynamic Pressure:** Provide exterior aluminum systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 300 Pa.

I. **Sound Transmission:** Provide exterior aluminum-framed systems with fixed glazing and framing areas having minimum STC 30 according to ASTM E 413 and an OITC 26 according to ASTM E 1332, as determined by testing according to ASTM E 90.

1.4 SUBMITTALS

A. **Product Data:** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.

B. **Shop Drawings:** For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include structural analysis data signed and sealed by the qualified professional Consultant responsible for their preparation.

2. Include details of provisions for system expansion and contraction and for draining moisture occurring within the system to the exterior.

3. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

C. **Samples for Initial Selection:** For units with factory-applied color finishes.

D. **Samples for Verification:** For each type of exposed finish required, in manufacturer's standard sizes.

E. **Fabrication Sample:** Of each vertical-to-horizontal intersection of systems, made from 300-mm lengths of full-size components and showing details of the following:

1. Joinery.

2. Anchorage.

3. Expansion provisions.

4. Glazing.

5. Flashing and drainage.

F. **Welding certificates**.

G. **Qualification Data:** For Installer and testing agency.

H. **Preconstruction Sealant Test Reports:** For structural-sealant-glazed systems, compatibility and adhesion test reports from sealant manufacturer indicating that materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with sealants. Include sealant manufacturer's interpretation of test results for sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.

I. **Product Test Reports:** Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems.

J. Field quality-control test and inspection reports.

K. **Maintenance Data:** For aluminum-framed systems to include in maintenance manuals.

L. **Warranties:** Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Installer Qualifications:** Capable of assuming Consultting responsibility and performing work of this Section and who is acceptable to manufacturer.

1. Consultanting Responsibility: Preparation of data for aluminum-framed systems including Shop Drawings based on testing and Consultanting analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.

C. **Testing Agency Qualifications:** An independent agency qualified according to ASTM E 699 for testing indicated.

D. **Product Options:** Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Consultant, except with Consultant's approval. If modifications are proposed, submit comprehensive explanatory data to Consultant for review.

E. **Welding:** Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code-Aluminum."

F. **Mockups:** Prior to installing aluminum entrances, construct one mockup for an exterior aluminum entrances to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for Work. Include class, glazing materials and spandrel panels.

1. Locate mockups on-site in the location and of the size indicated on Drawings.

2. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain Consultant's approval of mockups before start of Work.

5. Retain and maintain mockups during construction in an undisturbed conditions as a standard for judging the completed Work.

    a. Approved mockups in an undisturbed condition at the time of Substantial Completion as judged solely by the Consultant may become part of the completed Work, otherwise dismantle mockup and install permanent works.

1.6 PROJECT CONDITIONS

A. **Field Measurements:** Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

A. **Special Assembly Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures including, but not limited to, excessive deflection.

    b. Noise or vibration caused by thermal movements.

    c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

    d. Water leakage through fixed glazing and framing areas.

    e. Failure of operating components to function properly.

2. Warranty Period: Five years from date of Substantial Completion.

B. **Special Finish Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. **Aluminum:** Alloy and temper recommended by manufacturer for type of use and finish indicated, but not less than alloy and temper 6063 T5. Minimum wall thickness of extrusions for main ribs shall be 2.00 mm.

1. Sheet and Plate: ASTM B 209M.

2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221M.

3. Extruded Structural Pipe and Tubes: ASTM B 429.

4. Structural Profiles: ASTM B 308/B 308M.

5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

2.2 FRAMING SYSTEMS

A. **Framing Members:** Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

B. **Brackets and Reinforcements:** Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. **Fasteners and Accessories:** Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.

2. Reinforce members as required to receive fastener threads.

3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

2.3 WEATHER-STRIPPING

A. **Compression Weather stripping:** Cellular elastomeric preformed gasket and sealing material of vulcanized rubber, EPDM or neoprene, to ASTM D 2000

2.4 GLAZING SYSTEMS

A. **Glass Type:** As indicated on Drawings and specified in Division 8, Section "Glazing".

B. **Glazing Material:** As specified in Division 8 Section "Glazing."

C. **Bond-Breaker Tape:** Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.5 DOORS

A. **Doors:** Manufacturer's standard glazed doors, for manual swing operation.

1. Door Construction: 44-mm overall thickness unless otherwise indicated on Drawings, with minimum 5-mm, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.

2. Door Design: Wide stile; 127-mm nominal width.

3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

a. Provide non removable glazing stops on outside of door.

2.6 HARDWARE

A. **General:** Provide heavy-duty hardware units indicated in sizes, number, and type recommended by manufacturer for swing doors indicated and fabricated from cast, wrought or extruded aluminum. Finish exposed parts to match door finish, unless otherwise indicated.

B. Pivot Hinges:

1. Standard: BHMA A156.4, Grade 1.

2. Offset-Pivot Hinges: Provide top, bottom and intermediated offset pivots at each door leave.

C. **Closers, General:** Comply with requirements of Division 8, Section “Door Hardware” and manufacturer's recommendations for closer size, depending on door size, exposure to weather, and anticipated frequency of use.

1. Closing Cycle: Comply with requirements of authorities having jurisdiction.

2. Opening Force:Comply with the following maximum opening-force requirements for locations indicated:

a. Exterior Doors: 15 lbf (67 N).

D. Hardware for Swing Doors:

1. Hinges: As specified.

2. Door Pulls: Provide manufacturer's standard aluminum pull grips.

3 Door Stops: Floor-or-wall-mounted door stop as appropriate, with integral rubber bumper complying with ANSI A 156.16, Grade 1.

4. Keyed Cylinders: Mortise-type, 5-pin tumbler, stainless steel, inside cylinder units with cast aluminum face complying with ANSI A 156.5, Grade 1. Furnish 4 keys for each cylinder. Include cylinders in the master keying system

5. Locks: Roller type, for installation in aluminum styles of width indicated, aluminum casing.

6. Closers: As specified in this Section and in division 8, Section “Door Hardware”.

2.7 ACCESSORY MATERIALS

A. **Joint Sealants:** For installation at perimeter of aluminum-framed systems, as specified in Division 7 Section "Joint Sealants."

B. **Bituminous Paint:** Cold-applied asphalt-mastic paint complying with SSPC Paint 12 requirements except containing no asbestos, formulated for 0.75-mm thickness per coat.

2.8 FABRICATION

A. **General:** Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

B. Form aluminum shapes before finishing.

C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

D. **Framing Members, General:** Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.

2. Accurately fitted joints with ends coped or mitered.

3. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

4. Physical and thermal isolation of glazing from framing members.

5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

6. Provisions for field replacement of glazing from exterior or interior.

7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

E. **Mechanically Glazed Framing Members:** Fabricate for flush glazing (without projecting stops).

F. **Door Frames:** Reinforce as required to support loads imposed by door operation and for installing hardware.

1. At exterior doors, provide compression weather stripping at fixed stops.

2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

G. **Doors:** Reinforce doors as required for installing hardware.

1. At pairs of exterior doors, provide sliding weather stripping retained in adjustable strip mortised into door edge.

2. At exterior doors, provide weather sweeps applied to door bottoms.

H. **Hardware Installation:** Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.

I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

J. **Forming:** Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.

K. Prepare components to receive concealed fasteners and anchor and connection devices.

L. Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior.

M. **Welding:** Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

N. **Glazing Channels:** Provide minimum clearances for thickness and type of glass indicated according to FGMA's "Glazing Manual."

O. **Metal Protection:** Where aluminum will contact dissimilar metals, protect against

galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

P. **Entrances:** Fabricate door framing in profiles indicated. Reinforce as required to support imposed loads. Factory assemble door and frame units and factory install hardware to greatest extent possible. Reinforce door and frame units as required for installing hardware indicated. Cut, drill, and tap for factory-installed hardware before finishing components.

1. **Exterior Doors:** Provide compression weather stripping at fixed stops. At other locations, provide sliding weather stripping retained in adjustable strip mortised into door edge.

2.9 ALUMINUM FINISHES

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

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. **High-Performance Organic Finish (3-Coat Fluoropolymer):** AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Consultant from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION

A. Install aluminum swing doors in accordance with manufacturer's recommendations and approved shop drawings.

B. Install units plumb, level, square, true to line or curvature as required, in alignment with work of other trades, free from waves, buckles, sags or other defects. Provide secure anchorage for all parts of work. Coordinate with related trades to ensure proper mating and connecting of the work.

C. Isolate aluminum from contact with dissimilar metals and materials by applying on contact surfaces a heavy coat of approved alkali-resistant bituminous paint; or by separating surfaces with a non-absorptive tape or gasket.

D. Install work in prepared openings. Conform with applicable requirements for assuring use of proper materials and procedures to prevent electrolytic

deterioration.

E. Comply with manufacturer's instructions and recommendations for installation of work. Shim and allow for movement resulting from changes in thermal conditions.

F. Set frames level, plumb and in true alignment in accordance with approved shop drawings. Construct completely tight and waterproof assemblies. Provide proper support and anchor securely in place.

G. Provide sealing as necessary to make work watertight and properly finished including joints between frames and adjoining construction.

H. **Moving Parts:** There shall be no aluminum to aluminum contact between hardware parts or swing doors members which move relative to each other and remain in contact.

I. **Hardware:** Install hardware to hardware manufacturer's instructions and installation templates.

3.3 FIELD QUALITY CONTROL\

A. **Testing Agency:** Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. **Test Services:** Test aluminum swing doors as part of the assembly including them as specified in relevant Specifications Sections.

3.4 ADJUSTING

A. Adjust operating swing doors and hardware to provide a tight fit at contact points and weather-stripping for smooth operation and weathertight closure.

3.5 CLEANING

A. Clean aluminum surfaces promptly after installing units. Avoid damaging protective coatings and finishes. Remove excess glazing and sealing compounds, dirt and other substances.

B. Lubricate hardware and the moving parts. Clean glass of pre-glazed units promptly after installing sliding glass door units.

C. Wash and polish glass on both faces not more than 4 days prior to the date scheduled for final inspection. Comply with manufacturer's recommendations for final cleaning and maintenance.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in other ways during the construction period, including by natural causes, accidents and vandalism at no additional cost to the Employer.

3.6 PROTECTION

A. Institute and maintain protective and other precautions required through remainder of construction period to ensure that except for normal weathering aluminum.

B. Aluminum swing doors units will be clean, neat and without damage or deterioration at time of Substantial Completion.

SECTION 21 – ALUMINUM WINDOWS

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes aluminum-framed windows

B. Related Sections include the following:

1. Division 8 Section "Aluminum Framed Entrances and Storefronts."

2. Division 8 Section "Glazing" for glazing requirements for aluminum windows, including those specified to be factory glazed.

1.3 DEFINITIONS

A. Structural test pressure, for uniform load structural test, is equivalent to 150 percent of design pressure.

1.4 PERFORMANCE REQUIREMENTS

A. **General:** Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified and that are of test size indicated below:

1. Size indicated on Drawings.

B. **Structural Performance:** Provide aluminum windows capable of withstanding the following, including wind loads based on passing AAMA/NWWDA 101/I.S.2, Uniform Load Structural Test, at basic wind speed indicated:

1. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length 19 mm, whichever is less, at design pressure based on structural computations.

2. Basic Wind Speed: As indicated in meters per second at 10 m above grade. Determine wind loads and resulting design pressures applicable to Project according to the following, based on mean roof heights above grade as indicated on Drawings:

a. Uniform Building Code, 1997 Edition, Exposure C, Basic Wind Speed 130 km/hr

C. **Air Infiltration:** Maximum rate not more than indicated when tested according to AAMA/NWWDA 101/I.S.2, Air Infiltration Test.

1. Maximum Rate: 2 cu. m/h x sq. m of area at an inward test pressure of 300 Pa.

D. **Water Resistance:** No water leakage as defined in AAMA/NWWDA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/NWWDA 101/I.S.2, Water Resistance Test.

1. Test Pressure: 20 percent of positive design pressure, but not more than 580 Pa.

E. **Thermal Transmittance:** Provide aluminum windows with a whole-window U-value maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 and ASTM E 1423.

1. U-Value: shall not exceed U-value specified for glass insulating units specified in Division 8, Section "Glazing".

F. **Sound Transmission Class:** Provide glazed windows rated for not less than 26 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

G. **Thermal Movements:** Provide aluminum windows, including anchorage, that accommodate thermal movements of units resulting from the following maximum change (range) in ambient and surface temperatures without buckling, distortion, opening of joints, failure of joint sealants, damaging loads and stresses on glazing and connections, and other detrimental effects. Base Consultanting calculation on actual surface temperatures of materials due to solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 35 deg C, ambient; 65 deg C material surfaces.

H. **Life-Cycle Testing:** Test according to AAMA 910 and comply with AAMA/ WDMA 101/I.S.2.

1.5 SUBMITTALS

A. **Product Data:** Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

B. **Shop Drawings:** Include plans, elevations, sections, details, hardware, attachments to other Work, operational clearances, and the following:

1. Mullion details, including reinforcement and stiffeners.

2. Joinery details.

3. Expansion provisions.

4. Flashing and drainage details.

5. Weather-stripping details.

6. Thermal-break details.

7. Glazing details.

8. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional Consultant responsible for their preparation and used to determine the following:

a. Structural test pressures and design pressures from basic wind speeds indicated.

b. Deflection limitations of glass framing systems.

C. **Samples for Initial Selection:** For units with factory-applied color finishes.

D. **Samples for Verification:** For aluminum window components required, prepared on Samples of size indicated below.

1. Main Framing Member: 300-mm- long, full-size sections of extrusions with factory-applied color finish.

2. Hardware: Full-size units with factory-applied finish.

3. Weather Stripping: 300-mm- long sections.

4. Consultant reserves the right to require additional samples that show fabrication techniques, workmanship, and design of hardware and accessories.

E. Qualification Data: For manufacturer, Installer, and testing agency.

1. Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer's representative.

F. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

G. **Product Test Reports:** Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each type, grade, and size of aluminum window. Test results based on use of down-sized test units will not be accepted.

H. **Maintenance Data:** For operable window sash, operating hardware, weather stripping and finishes to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Manufacturer Qualifications:** A firm experienced in manufacturing items specified in this section similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to manufacture required units.

C. **Installer Qualifications:** An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1. A qualified firm specializing in performing the work of this Section with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Consultants and Employers, and other information specified

D. **Testing Agency Qualifications:** An independent testing agency, acceptable to Consultant, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

E. **Source Limitations:** Obtain aluminum windows through one source from a single manufacturer.

F. **Fenestration Standard:** Comply with AAMA/WDMA 101/I.S.2, "Voluntary Specifications

for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors," for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

G. **Mockups:** Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.

1. Build mockup in building envelope wall in locations selected by Consultant.

2. Build one mockup of each type of windows indicated on Drawings.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion as judged solely by the Consultant, otherwise dismantle mockups, remove site and install permanent works.

H. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. **Field Measurements:** Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. **Special Warranty:** Provide written warranty signed by Manufacturer and Contractor in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Failure to meet performance requirements.

2. Structural failures including excessive deflection.

3. Water leakage, air infiltration, or condensation.

4. Faulty operation of movable sash and hardware.

5. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

6. Insulting glass failure.

B. Warranty Period: 5 years from date of Substantial Completion.

C. Warranty Period for Metal Finishes: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. **Aluminum Extrusions:** Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 150-MPa ultimate tensile strength, not less than 110-MPa minimum yield strength, and not less than 2.00 mm thickness at any location for the main frame and sash members.

B. **Fasteners:** Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum window members, trim, hardware, anchors, and other components

1. Reinforcement: Where fasteners screw-anchor into aluminum less than 3.2 mm thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, non-corrosive, pressed-in, splined grommet nuts.

2. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.

C. **Anchors, Clips, and Accessories:** Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

D. **Reinforcing Members:** Aluminum or nonmagnetic stainless steel, complying with ASTM B 456 for Type SC 3 severe service conditions, provide sufficient strength to withstand design pressure indicated.

E. **Sliding-Type Weather Stripping:** Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.

1. Sliding Weather Stripping: Wool, polypropylene, or nylon woven pile with nylon--fabric or aluminum-strip backing complying with AAMA 701/702 requirements.

F. **Compression-Type Weather Stripping:** Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when aluminum window is closed.

1. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864 fabricated from EPDM.

G. **Replaceable Weather Seals:** Comply with AAMA 70 1/702.

H. **Sealant:** For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

2.2 GLAZING

A. **Glass and Glazing Materials:** Refer to Division 8 Section "Glazing" for glass units and glazing requirements applicable to glazed aluminum window units.

B. **Glazing System:** Manufacturer's standard factory-glazing system that produces weather tight seal or as indicated in Division 8 Section "Glazing".

2.3 HARDWARE

A. **General:** Provide manufacturer's standard hardware fabricated from aluminum, designed to smoothly operate, tightly close, and securely lock aluminum windows and sized to accommodate sash or ventilator weight and dimensions. Cadmium- plated hardware is not permitted. Do not use aluminum in frictional contact with other metals. Where exposed, provide extruded, cast, or wrought aluminum with clear anodized satin finish.

B. **Hardware, General:** Comply with AAMA 902.

C. **Sill Cap/Track:** Extruded-aluminum with finish matching that of window track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.

D. **Locks and Latches:** Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.

E. **Roller Assemblies:** Low-friction design.

F. **Four- or Six-Bar Friction Hinges:** Comply with AAMA 904.

1. Locking mechanism and handles for manual operation.

2. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, non staining, non-corrosive, durable material.

G. **Limit Devices:** Provide limit devices designed to restrict sash or ventilator opening.

1. Safety Devices: Limit clear opening to 150 mm for ventilation; with custodial key release.

H. **Horizontal-Sliding Windows:** Provide the following operating hardware:

1. Sash Rollers: Stainless-steel, lubricated ball-bearing rollers with nylon tires.

2. Sash Lock: Spring-loaded, snap-type lock at jambs; two per sash.

I. Projected Windows: Provide the following operating hardware:

1. Hinge: Five-knuckle butt hinge.

2. Lock: Combination lever handle and cam-action lock with concealed pawl and keeper.

3. Limit Device: Concealed friction adjustor, adjustable stay bar limit device; located on jamb of each ventilator.

2.4 FABRICATION

A. **General:** Fabricate aluminum windows, in sizes indicated, that comply with AAMA/WDMA 101/I.S.2 for performance class and performance grade indicated. Include a complete system for assembling components and anchoring windows.

B. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.

C. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

1. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.

2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.

3. Provide hardware with low conductivity for hardware bridging thermal breaks at frame or vent sash.

D. **Weather Stripping:** Provide full-perimeter weather stripping for each operable sash and ventilator.

E. **Weep Holes:** Provide weep holes and internal passages to conduct infiltrating water to exterior.

F. **Mullions:** Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

G. **Sub-frames:** Provide sub-frames with anchors for window units as shown, of profile and dimensions indicated but not less than 1.6-mm- thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units. Provide subframes capable of withstanding design loads of window units.

H. **Factory-Glazed Fabrication:** Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 8 Section "Glazing" and with AAMA/WDMA 101/I.S.2.

I. **Glazing Stops:** Provide snap-on glazing stops coordinated with Division 8 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

2.5 FINISHES

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

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. **High-Performance Organic Finish (3-Coat Fluoropolymer):** AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Consultant from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances; rough opening dimensions; levelness of sill plate; coordination with wall flashings, vapor retarders, and other built-in components; operational clearances and other conditions affecting performance of work.

1. Masonry and Concrete Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.

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

3.2 INSTALLATION

A. **General:** Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components; Drawings; and Shop Drawings.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in "Dissimilar Materials" Paragraph in Appendix B in AAMA/WDMA 101/I.S.2.

3.3 ADJUSTING

A. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weather-tight closure. Lubricate hardware and moving parts.

3.4 PROTECTION AND CLEANING

A. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

SECTION 22 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Commercial door hardware for the following steel and wood doors:

a. Swinging doors.

2. Cylinders for doors specified in other Sections.

3. Electrified door hardware.

B. Related Sections include the following:

1. Division 8 Section "Custom Steel Doors and Frames" for astragals provided as part of a fire-rated labeled assembly and for door silencers provided as part of the time.

2. Division 8 Section "Flush Wood Doors" for astragals provided as part of a fire-rated labeled assembly.

3. Division 8 Section "Access Doors and Frames".

4. Division 8 Section "Overhead Coiling Doors".

5. Division 8 Section "Aluminum Framed Entrances And Storefronts".

6. Division 8 Section "Sliding Automatic Entrance Doors" for entrance door hardware, except cylinders.

7. Division 16 Electrical Specification Systems for coordination of electrical hardware and security hardware.

C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1. Cylinders for locks on aluminum and glass entrance doors.

1.3 SUBMITTALS

A. **Product Data:** Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. **Shop Drawings:** Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:

a. System schematic.

b. Point-to-point wiring diagram.

c. Riser diagram.

d. Elevation of each door.

2. Detail interface between electrified door hardware and fire other building systems.

C. **Samples for Initial Selection:** Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.

D. **Samples:** For exposed door hardware of each type indicated below, in specified finish, full size. Tag with full description for coordination with the Door Hardware Schedule. Submit samples before, or concurrent with, submission of the final Door Hardware Schedule.

1. Door Hardware: Each piece of hardware indicated in hardware schedule or on Drawings.

2. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

E. **Door Hardware Schedule:** Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.

a. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.

b. Manufacturer of each item.

c. Fastenings and other pertinent information.

d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.

e. Explanation of abbreviations, symbols, and codes contained in schedule.

f. Mounting locations for door hardware.

g. Door and frame sizes and materials.

h. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.

1) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.

4. **Submittal Sequence:**

a. Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

b. Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit the final Door Hardware Schedule after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.

F. **Keying Schedule:** Prepared by or under the supervision of supplier, detailing Employer's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

G. **Product Certificates:** Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.

1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.

H. **Qualification Data:** For firms and persons specified in "Quality Assurance" Article.

1. Include lists of completed projects with project names and addresses of architects/Consultants and owners, and other information specified.

I. **Product Test Reports:** Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, indicating current products comply with requirements.

J. **Maintenance Data:** For each type of door hardware to include in maintenance manuals specified in Division 1.

K. **Warranties:** Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Installer Qualifications:** A qualified firm specializing in performing the work of this Section and who has completed door hardware similar in material, design, and extent to that indicated for this Project with minimum three years documented experience and that is approved, authorized, or licensed by the product

manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Consultants and Employers, and other information specified

C. **Supplier Qualifications:** A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying conventional and security door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Employer, Consultant, and Contractor, at reasonable times during the course of the Work, for consultation. The supplier shall have access to adequate inventory of all hardware items to meet Project construction schedules and shall have the ability to submit samples, hardware data, templates, and hardware schedules in accordance with Project construction schedules.

1. Require supplier to meet with Employer to finalize keying

2. Electrified Door Hardware Supplier Qualifications: An experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.

    a. Consultanting Responsibility: Prepare data for electrified door hardware, including Shop Drawings, based on testing and Consultanting analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

3. Scheduling Responsibility: Preparation of door hardware and keying schedules.

C. **Architectural Hardware Consultant Qualifications:** A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

1. Electrified Door Hardware Qualifications: Experienced in providing consulting services for electrified door hardware installations.

D. **Source Limitations:** Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.

E. **Regulatory Requirements:** Comply with provisions of the following:

1. NFPA 101: Comply with the following for means of egress doors:

    a. Latches, Locks, and Exit Devices: Not more than 67 N to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.

    b. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force not more than 67 N for not more than 3 seconds.

c. Door Closers: Not more than 133 N to set door in motion and not more than 67 N to open door to minimum required width.

d. Thresholds: Not more than 13 mm high.

2. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

F. **Fire-Rated Door Assemblies:** Provide door hardware for assemblies complying with NFPA 80, or any approved equal international standard, that are listed and labeled by a testing and inspecting agency acceptable to Consultant, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure.

G. **Labels:** All hardware components of fire resisting doors assemblies including, but not limited hinges, locks, bolts, door closers shall carry the identifying labels of an approved independent testing and inspection agency or laboratory, confirming their fire resistance rating. The rating of all door components shall be equal to the rating of the door assembly.

H. **Door Closers on Fire Rated Doors:** Comply with requirements with specified in Clause 2.10 of this Section.

I. **Keying Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings." Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.

2. Preliminary key system schematic diagram.

3. Requirements for key control system.

4. Address for delivery of keys.

J. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings." Review methods and procedures related to electrified door hardware including, but not limited to, the following:

1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.

2. Review sequence of operation for each type of electrified door hardware.

3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review required testing, inspecting, and certifying procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver keys to manufacturer of key control system.

D. Deliver keys to Employer by registered mail or overnight package service.

1.6 COORDINATION

A. Coordinate layout and installation of recessed pivots and closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

B. **Templates:** Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. **Electrical System Roughing-in:** Coordinate layout and installation of electrified door hardware with connections to power supplies and fire alarm system and detection devices and any other building system as indicated on Drawings.

1.7 WARRANTY

A. **General Warranty:** Special warranties specified in this Article shall not deprive Employer of other rights Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. **Special Warranty:** Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.

2. Faulty operation of operators and door hardware.

3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. **Warranty Period:** Three years from date of Substantial Completion, unless otherwise indicated.

D. **Warranty Period for Electromagnetic and delayed-Egress Locks:** Five years from date of Substantial Completion.

E. **Warranty Period for Manual Closers:** 10 years from date of Substantial Completion.

F. **Warranty Period for Concealed Floor Closers:** Five years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. **Maintenance Tools and Instructions:** Furnish a complete set of specialized tools and maintenance instructions as needed for Employer's continued adjustment, maintenance, and removal and replacement of door hardware.

B. **Maintenance Service:** Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies as used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. **General:** Provide door hardware for each door to comply with requirements in this Section, and the Door and Hardware sets Schedule annexed at the end of Part 3.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.

2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. **Designations:** Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door and Hardware sets Schedule at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. International hardware manufactures have to establish their compliance with these specifications and with international fire codes for fire rated hardware.

2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

2.2 HINGES AND PIVOTS

A. **Standards:** Comply with the following:

1. Butts and Hinges: BHMA A156.1.

2. Template Hinge Dimensions: BHMA A156.7.

3. Self-Closing Hinges and Pivots: BHMA A156.17.

4. Pivots: BHMA A156.4.

B. **Size:** Provide the following minimum sizes, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Max: Door Size (mm)	Hinge height (mm)	Standard Weight	Heavy Weight
800 by 2125 by 35	80	3.1	-
900 by 2125 by 35	100	3.3	-
900 by 2285 by 38	113	3.4	4.6
1050 by 2285 by 38	113	3.4	4.6

1200 by 3050 by 38	125	3.7	4.8

C. **Template Requirements:** Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

D. **Hinge Weight:** Unless otherwise indicated, provide the following:

1. Entrance Doors: Heavy-weight hinges.

2. Doors with Closers: Antifriction-bearing hinges.

3. Interior Doors: Standard-weight hinges.

E. **Hinge Base Metal:** Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel alloy 316, with stainless-steel pin

2. Interior Hinges: Stainless steel alloy 304, with stainless-steel pin.

3. Hinges for Fire-Rated Assemblies: Stainless steel alloy 304, with stainless-steel pin.

F. **Hinge Options:** Comply with the following where indicated in the Door Hardware Schedule or on Drawings:

1. Maximum Security Pin: Fix pin in hinge barrel after it is inserted.

2. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:

   a. Out-swinging exterior doors.

3. Corners: 4-mm radius.

G. **Hinges, General:** Shall be full mortise, template, of concealed ball bearing, 5 knuckles, suitable for high frequency applications and of life time warranty.

2.3 LOCKS AND LATCHES

A. **Standards:** Comply with the following: Mortise Locks and Latches: BHMA A156.13.

1. Interconnected Locks and Latches: BHMA A156.12.

2. Auxiliary Locks: BHMA A156.5.

3. Push-Button Combination Locks: BHMA A156.2.

4. Electromagnetic Locks: BH MA A156.23.

5. Delayed-Egress Locks: BH MA A156.24.

6. Exit Locks: BHMA A156.5.

B. **Mortise Locks:** Stamped steel case with stainless steel parts; BHMA Grade 1; Series 1000. Provide mortise locks for exterior doors, throughout the job, except for toilets. All lock shall be ADA compliant Marine grade mortise locks shall be provided

in the exterior and in non air conditioned areas. Provide ten years product warranty for performance and finish.

C. **Mortise Lock:** Shall be types produced for extra-heavy-duty applications. Lock lever shall be of anti-vandalism design.

D. Where threaded bars are used to assemble the two pieces of lock spindle, minimum inner diameter of threading bar shall be 6 mm.

E. **Interconnected Locks:** BHMA Grade 1; Series 5000.

F. **Auxiliary Locks:** BHMA Grade 1.

G. **Push-Button Combination Locks:** BHMA Grade 1 for cylindrical locks and Grade 2 for mortise locks.

H. **Certified Products:** Provide door hardware listed in the following BHMA directories:

1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."

I. **Lock Trim:** Comply with the following: All trims to have returns. Trims shall be ADA compliant. Trim shall be stainless steel BHMA-630

1. Lever: Wrought, forged, or cast.

2. Escutcheon (Rose): Wrought, forged, or cast.

3. Dummy Trim: Match lock trim and escutcheons.

4. Lockset Designs: Provide the lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:

J. **Lock Functions:** Function numbers and descriptions indicated in the Door Hardware Schedule comply with the following:

1. Mortise Locks: BHMA A156.13.

2. Interconnected Locks: BHMA A156.12.

K. **Lock Features:** Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Mortise Locks: Minimum 19-mm latchbolt throw.

2. Deadbolts: Minimum 25-mm bolt throw.

3. Pairs of Doors: 16-mm minimum throw of latch.

4. Fire-Rated Doors: Comply with UL requirements for throw of bolts and latches on rated fire openings.

5. Heavy duty anti friction tongue.

6. Non handed auxiliary guard latch.

7. Adjustable stainless steel armor front.

8. Seven pin interchangeable core cylinder.

9. Corrosion protected steel case.

L. **Rabbeted Doors:** Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.

M. **Backset:** 70 mm, unless otherwise indicated.

N. **Lock Function:** Provide lock functions as described below, but not limited to

1. F-04 Office lock, with faceplate button depressed function.

2. Classroom function for stores

3. F-13 Corridor lock.

4. Provide classroom dead bolts for main doors of toilets and janitors rooms Additional lock function will be required as per function of various rooms.

O. Locks shall have double buttons in face plate. For Office Locks the handle will rotate only when bottom button is depressed or turning key for outside cylinder. For other locks, the bottom button in face plate shall also retract the latch.

P. These requirements for mortise locks shall remain applicable in all respects for wood doors, steel doors and minimum doors.

2.4 DOOR BOLTS

A. **Standards:** Comply with the following:

1. Surface Bolts: BHMA A156.16.

2. Manual Flush Bolts: BHMA A156.16.

B. Surface Bolts: BHMA Grade 1.

1. Flush Bolt Heads: Minimum of 13-mm- diameter rods of brass, bronze, or stainless steel with minimum 300-mm- long rod for doors up to 2100 mm in height. Provide longer rods as necessary for doors exceeding 2100 mm.

C. Flush Bolts: BHMA Grade 1, designed for mortising into door edge.

D. **Bolt Throw:** Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Half-Round Surface Bolts: Minimum 22-mm throw.

2. Interlocking Surface Bolts: Minimum 24-mm throw.

3. Fire-Rated Surface Bolts: Minimum 25-mm throw; listed and labeled for fire-rated doors.

4. Dutch-Door Bolts: Minimum 19-mm throw.

5. Mortise Flush Bolts: Minimum 19-mm throw.

2.5 EXIT DEVICES

A. **Standard**: BHMA A156.3.

1. BHMA Grade: Grade 1.

B. **Certified Products:** Provide exit devices listed in BHMA's "Directory of Certified Exit Devices."

C. **Panic Exit Devices:** Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

D. **Panic Exit Devices:** For non-fire rated doors are to be as specified in Sub-Clause but with facility to hold latchbolts in retracted position so that the doors may be used as push/pull. Dogging is to be accomplished by a hex key cylinder installed on the body of touch bar devices or a hexagonal key in the hinge and lock cases of cross bar devices

E. **Fire Exit Devices:** Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

F. **Dummy Push Bar:** Nonfunctioning push bar matching functional push bar.

1. Operation: Rigid.

G. **Outside Trim:** Lever with cylinder or Pull with cylinder; unless otherwise indicated material and finish to match locksets, unless otherwise indicated.

1. Match design for locksets and latchsets, unless otherwise indicated.

H. **Through Bolts:** For exit devices and trim on metal doors and non-fire-rated wood doors.

I. Fire and panic exit devices shall be of concealed latches. No exposed latches shall be accepted.

2.6 CYLINDERS AND KEYING

A. **Standards:** Comply with the following:

1. Cylinders: BHMA A156.5.

2. Key Control System: BHMA A156.5.

B. Cylinder Grade: BHMA Grade 1 or Grade 1A.

C. **Cylinders:** Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Seven.

2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.

3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.

D. **Permanent Cores:** Manufacturer's standard; finish face to match lockset; complying

with the following:

1. Interchangeable Cores: Core insert, removable by use of a special key, and usable with other manufacturers' cylinders.

2. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

E. Construction Keying: Comply with the following:

1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

2. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 4 constructions master keys for Employer/Consultant use.

   a. Replace construction cores with permanent cores, as directed by Employer.

   b. Furnish permanent cores to Employer for installation.

F. **Keying System:** Unless otherwise indicated, provide a factory-registered keying system complying with the following requirements:

1. Master Key System: Cylinders are operated by a change key and a master key.

G. **Keys:** Provide stainless steel keys complying with the following:

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

   a. Notation: Information to be furnished by Employer.

2. Quantity: In addition to one extra blank key for each lock, provide the following:

   a. Cylinder Change Keys: Three.

   b. Master Keys: Five.

H. **Key Control System:** BHMA Grade 1 system, including key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers. Contain system in metal cabinet with baked-enamel finish.

1. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.

2. Capacity: Able to hold keys for 150 percent of the number of locks.

3. Cross-Index System: Set up by key control manufacturer, complying with the following:

   a. Card Index: Furnish four sets of index cards for recording key information. Include three receipt forms for each key-holding hook.

2.7 STRIKES

A. **Standards:** Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.

2. Strikes for Interconnected Locks and Latches: BHMA A156.12.

3. Strikes for Auxiliary Deadlocks: BHMA A156.5.

4. Dustproof Strikes: BHMA A156.16.

B. **Strikes:** Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

4. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.

5. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non recessed strike for bolt.

C. **Dustproof Strikes**: BHMA Grade 1.

2.8 CARD READER

A. Proximity Reader with Keypad:

1. Technology: Wiengand proximity system compatible with building security system.

2. Housing: Weather resistant ABS plastic housing. Color as selected by Consultant from manufacturer’s full line.

3. Key Pad: 12 button key pad for entry of Personal Identification Number (PIN) in addition to proximity card.

4. Display Status: 3 LED status display and controllable beeper to indicate reader operation and status.

5. Tamper Detection: Mechanical tamper switch to send signal to security room if reader is completely removed from wall in addition to detecting when reader has been separated from its back plate.

6. Provide all mounting plates, cables, programs and other items required to make card reader work with building security system.

2.9 OPERATING TRIM

A. **Standard:** Comply with BHMA A156.6.

B. Door handles shall have returns in direction of door, straight handles shall not be accepted.

C. Handles shall be with round (rose) cover plates.

D. **Materials:** Fabricate from stainless steel, unless otherwise indicated.

E. Push-Pull Design: As indicated on Drawings.

2.10 ACCESSORIES FOR PAIRS OF DOORS

A. **Standards:** Comply with the following:

1. Coordinators: BHMA A156.3.

B. **Carry-Open Bars:** Provide carry-open bars for inactive leaves of pairs of doors, unless automatic or self-latching bolts are used.

C. Do not use security astragals. Use split adjustable astragals or concealed side mounted

2.11 CLOSERS

A. Closers, General-unless otherwise indicated, provide closers on all fire-rated doors, exterior doors, toilet and locker room doors, sound-retardant doors, corridor doors, doors between heated/cooled and unheated / uncooled areas, elevator equipment room doors, and other door as required. Closer shall be tested for 10 million cycles and will withstand 57 degree ambient temperature and will be provided with all weather hydraulic fluid. Closer will be equipped with the function of variable back check and delayed action. Closer will be provided with ten years warranty and warranty against leaks. Closer will be non banded. Closer will be provided with adjustable with speed and hold open facility. Concealed door closer will be completely and components will minimize tempering and vandalism.

1. Size of Units: Unless otherwise indicated, comply with the manufacturer's recommendation for size of door control unit depending on size of door, exposure to weather and drafts, and anticipated frequency of use.

2. Arms: Provide parallel arms for all overhead closers, unless otherwise indicated. Provide closer unit one size larger than recommended for use with standard arms.

3. Closing Cycle: Comply with requirements of authorities having jurisdiction or the Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)", whichever are most stringent

a. Opening Force: Comply with the following maximum opening-force requirements for locations indicated:

1) Exterior Doors: 67 N.

2) Interior Doors: 22.2N.

4. Construction: Provide marine-grade construction for closers in non-air conditioned areas and in door swimming pool areas, consisting of nonferrous and stainless steel components.

B. **Aluminum Entrance Doors:** Provide concealed door closer. Standards: Comply with the following:

1. Closers: BHMA A156.4.

C. Surface Closers: BHMA Grade 1.

D. **Concealed Closers:** BHMA Grade 1.

E. **Certified Products:** Provide door closers listed in BHMA's "Directory of Certified Door Closers".

F. **Door Closers on Fire Rated Doors:** Shall be type that closes the door and positively latch the door.

G. **Hold-Open Closers/Detectors:** Coordinate and interface integral smoke detector and closer device with fire alarm system. Fire rated doors with closers of hold open facility shall release automatically in case of fire based on signal from the fire alarm system (electric release door closer). System of release device for double leaf fire rated doors shall be adjustable so as the inactive leaf shall close prior to the active leaf and that active leave shall positively latch to the inactive leaf at final closing position (electric release door closers and door coordinator).

G. **Flush Floor Plates:** Provide finish cover plates for floor closers unless thresholds are indicated. Match door hardware finish, unless otherwise indicated.

H. **Recessed Floor Plates:** Provide recessed floor plates with insert of floor finish material for floor closers, unless thresholds are indicated. Provide extended closer spindle to accommodate thickness of floor finish.

I. Weather Comply with manufacturer's written recommendation of exposure to weather. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

J. **Grade:** Door closers shall be from types tested for 10 millions cycles of operation and sized for door leafs of minimum weight of 200 kilogram per leaf for both steel doors and external doors.

2.12 PROTECTIVE TRIM UNITS

A. **Standard:** Comply with BHMA A156.6.

B. **Materials:** Fabricate protection plates from the following to match requirement indicate:

1. Stainless Steel: beveled top and 2 sides.

C. Protection Plates, General:

1. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.

D. **Kick Plates:** beveled top and two side edges (B3E). Provide two kick plates for toilet doors. Kick plate will ensure that the door bottom is protected.

a. Metal Plates: Stainless steel, 3.00 mm thick

E. **Armor Plates:** 3 mm thick, 914 mm high by full width of door less clearance for stops on door frame.

F. **Fasteners:** Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.

G. Furnish protection plates sized 38 mm less than door width on push side and 13 mm less than door width on pull side, by height specified in Door Hardware Schedule.

2.13 STOPS AND HOLDERS

A. **Standards:** Comply with the following:

1. Stops and Bumpers: BHMA A156.16.

2. Mechanical Door Holders: BHMA A156.16.

3. Electromagnetic Door Holders: BHMA A156.15.

4. Combination Overhead Holders and Stops: BHMA A156.8.

5. Door Silencers: BHMA A156.16.

B. **Stops and Bumpers:** BHMA Grade 1.

C. **Mechanical Door Holders:** BHMA Grade 1.

D. **Combination Floor and Wall Stops and Holders:** BHMA Grade 1.

E. **Combination Overhead Stops and Holders:** BHMA Grade 1.

F. **Electromagnetic Door Holders for Labeled Fire Door Assemblies:** Coordinate with fire detectors and interface with fire alarm system.

G. **Floor Stops:** For doors, unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.

1. Where floor or wall stops are not appropriate, provide overhead holders.

H. **Silencers for Wood Door Frames:** BHMA Grade 1; neoprene or rubber, minimum 16 by 19 mm; fabricated for drilled-in application to frame.

I. **Silencers for Metal Door Frames:** BHMA Grade 1; neoprene or rubber, minimum diameter 13 mm; fabricated for drilled-in application to frame.

2.14 DOOR GASKETING

A. **Standard:** Comply with BHMA A156.22.

B. **General:** Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. **Air Leakage:** Not to exceed 0.000774 cu. m/s per m of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.

D. **Smoke-Labeled Gasketing:** Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.

1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.

E. **Fire-Labeled Gasketing:** Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL 10B or NFPA 252.

F. **Sound-Rated Gasketing:** Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

G. **Replaceable Seal Strips:** Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

H. **Gasketing Materials:** Comply with ASTM D 2000 and AAMA 70 1/702.

I. **Weather-stripping and Seal Types:** Unless otherwise indicated, provide the following, or approved equal:

1. Door Shoes: Extruded aluminum, with vinyl seal and integral rain drip.

2. Rain Drips: Extruded aluminum. Unless noted otherwise, provide rain drips for all exterior doors.

3. Automatic Door Bottoms: Extruded aluminum with neoprene insert for doors to achieve STC of 47 or better, as indicated in the hardware schedule.

4. Meeting Stile Seals (Astragal Seals): Extruded anodized aluminum, with silicon seal.

5. Weather-stripping, Smoke Seals, and Sound Retarding Gaskets: Compression-type self-adhesive silicone gasket applied to door stops, white color.

6. Security Astragals: Cam operated, automatic security astragal.

2.15 THRESHOLDS

A. **General:** Unless otherwise indicated, provide standard metal threshold units of type, size, and profile as shown or scheduled. Comply with ANSI/BHMA A156.21.

1. Material: Extruded aluminum, non-slip finish, except as otherwise specified.

2. Exterior Hinged Doors: Provide units not less than 100 mm wide, and not more than 12-mm-high, with beveled edges providing a floor level change with a slope of not more than 1:2, formed to accommodate change in floor elevation where indicated, fabricated to accommodate door hardware and to fit door frames, and as follows:

    a. For in-swinging doors provide units with interlocking lip and interior drain channel; include hook on bottom edge of door and drain pan.

    b. For out-swinging doors provide rabbeted type units with replaceable weather-strip insert in stop. Provide threshold with thermal break when mentioned in the hardware schedule

B. **Exterior Thresholds:** ANSI/BHMA A156.21, extruded aluminum. Provide flat saddle type or interlocking type with resilient insert as shown.

C. **Threshold for Aluminum Entrance Doors:** Manufacturer's standard threshold with cutouts coordinated for operating hardware, with anchors and jamb clips, and not more than 12-mm-high, with beveled edges providing a floor level change with a slope of not more than 1:2, formed to accommodate change in floor elevation where indicated.

D. **Threshold for Doors with Exit Devices:** Extruded aluminum latching type, with replaceable vinyl inserts.

E. Interior Thresholds: Extruded aluminum flat saddle type with smooth surface.

2.16 MISCELLANEOUS DOOR HARDWARE

A. **Standard:** Comply with the following:

1. Auxiliary Hardware: BHMA A156.16.

2. Exit Alarms: BHMA A156.5.

B. **Auxiliary Hardware:** BHMA Grade 1, unless otherwise indicated.

C. **Boxed Power Supplies:** Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labeled for use with fire alarm systems.

2.17 FABRICATION

A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Consultant.

1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. **Base Metals:** Produce door hardware units of base metal specified, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish

manufacturer's standard materials or forming methods if different from specified standard.

C. **Fasteners:** Provide door hardware manufactured to comply with published

templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Steel Machine or Wood Screws: For the following fire-rated applications:

   a. Mortise hinges to doors.

   b. Strike plates to frames.

   c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:

   a. Surface hinges to doors.

   b. Closers to doors and frames.

   c. Surface-mounted exit devices.

4. Spacers: For through bolting of hollow metal doors.

5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.18 BASE METAL

A. Base Metal for hardware and door furniture shall be as follows:

1- Exterior Units: Stainless Steel alloy 316

2- Interior Units: Stainless Steel alloy 304

2.19 FINISHES

A. **Standard:** Comply with BHMA A156.18.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. **Appearance of Finished Work:** Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. **BHMA Designations:** Comply with base material and finish requirements indicated by the following:

1. BHMA 630: Satin stainless steel, over stainless-steel base metal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. **Steel Doors and Frames:** Comply with DHI A115 series.

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.

B. **Wood Doors:** Comply with DHI A115-W series.

3.3 INSTALLATION

A. **Mounting Heights:** Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."

2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. **Key Control System:** Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.

D. **Thresholds:** Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

3.4 ADJUSTING

A. **Initial Adjustment:** Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to

compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 75 mm from the latch, measured to the leading edge of the door.

B. **Six-Month Adjustment:** Approximately six months after date of Substantial Completion, Installer shall perform the following:

1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

2. Consult with and instruct Employer's personnel on recommended maintenance procedures.

3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is with out damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Employer's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

SECTION 23 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes glazing for the following products, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Aluiminum entrances.
2. Sliding automatic entrances doors.
3. Aluminum windows
4. Structure-Sealant-Glazed curtain walls..
5. Glass visions in doors.

B. **Related Sections:** The following sections contain requirements that relate to this Section.

Division 5 Section "Metal Fabrications".

1. Division 8 Section "Custom Steel Doors and Frames".
2. Division 8 Section "Aluminum-Framed Entrances and Storefornts".
3. Division 8 Section "Sliding Automatic Entrance Doors".
4. Division 8 Section "Aluminum Windows".
5. Division 8 Section "Mirrored Glass".
6. Division 8 Section "Structure-Sealant-Glazed Curtain Walls".

1.3 DEFINITIONS

A. **Manufacturer:** Manufacturer is used in this Section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

B. **Deterioration of Laminated Glass:** Defects developed from normal use that are attributed to the manufacturing process and not to glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's directions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated glass standard.

C. **Deterioration of Insulating Glass:** Failure of the hermetic seal under normal use due to causes other than glass breakage and improper practices for maintaining,

and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of glass. Improper practices for maintaining and cleaning glass do not comply with the manufacturer's directions.

1.4 PERFORMANCE REQUIREMENTS

A. **General:** Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.

B. **Glass Design:** Glass thicknesses indicated on Drawings shall be considered as the minimum only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites for the various size openings in the thicknesses and strengths (annealed or heat-treated) to meet or exceed the following criteria:

1. Minimum glass thickness, nominally, of lites shall be 6.0 mm.

2. Tinted and heat-absorbing glass thicknesses for each tint indicated shall be the same throughout Project.

3. Minimum glass thicknesses of lites, whether composed of annealed or heat-treated glass, shall be selected so the worst-case probability of failure does not exceed the following:

   a. Eight lites per 1000 for lites set vertically or not over 15 degrees off vertical and under wind action. Determine minimum thickness of monolithic annealed glass according to ASTM E 1300. For other than monolithic annealed glass, determine thickness per glass manufacturer's standard method of analysis including applying adjustment factors to ASTM E 1300 based on type of glass.

   b. One lite per 1000 for lites set over 15 degrees off vertical and under action of wind and rain.

C. **Thermal Movement:** Allow for normal thermal movement resulting from the following maximum change (range) in ambient and surface temperatures acting on glass-framing members and glazing components. Base Consultanting calculation on materials' actual surface temperatures due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 35 deg C ambient; 65 deg C material surfaces.

D. **Deflection:** Center deflection of loaded glass lites shall not exceed L/10t where L is the short span of the lite in mm and t is the thickness of the monolithic or laminated lite in mm.

E. **Loads on Glass:**

1. Glass shall be of appropriate thickness to withstand the greater of the following pressures, or combinations thereof, acting normal to the surface without center point deflections in excess of those specified. Load combinations shall be per the specific requirements of the 1997 Uniform Building Code:

   a. Wind Load: Positive and negative wind load shall be based on the UBC for a basic wind speed of 80 mph (130 km/h), Importance Factor 1.15, and Exposure Category "C".

   b. Human Impact Loads: Comply with CPSC 16 CFR 1201 Category II in those locations designated as hazardous locations by UBC Section

2406.4.

2. Calculate glass thickness based upon the following minimum safety factors.

   a. Vertical Glazing:

      1) Fully Tempered Glass (Type FT): 1.4.

1.5 SUBMITTALS

A. **Product Data:** For each glass product and glazing material indicated.

B. **Samples:** Samples for verification purposes of 300-mm-square samples of each type of glass indicated except for clear monolithic glass products, and 300-mm-long samples of each color required for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative in color of the adjoining framing system.

C. **Test Reports:**

1. Compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.

2. Compatibility test report from manufacturer of insulating glass edge sealant indicating that glass edge sealants were tested for compatibility with other glazing materials including sealants, glazing tape, gaskets, setting blocks, and edge blocks.

3. Product test reports for each type of glazing sealant and gasket indicated, evidencing compliance with requirements specified.

D. **Certificates:** Product certificates signed by glazing materials manufacturers certifying that their products comply with specified requirements.

1. Separate certifications are not required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program of a recognized certification agency or independent testing agency acceptable to authorities having jurisdiction.

E. **Maintenance Data:** For glass and other glazing materials to include in Operating and Maintenance Manual.

F. Consultanting Calculations:

1. Submit Consultanting calculations including glass fabricator/manufacturer's calculations for wind pressure analysis and thermal stress analysis.

2. Consultanting calculations shall be submitted concurrently with the corresponding shop drawings.

3. All calculations shall bear the stamp of a professional Consultant legally authorized to practice in the jurisdiction where Project is located and experienced in providing Consultanting services of the kind indicated.

1.6 QUALITY ASSURANCE

A. **Glazing Publications:** Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. AAMA TIR-A7 "Sloped Glazing Guidelines" and "Glass Design for Sloped Glazing".

2. FGMA "Glazing Manual".

3. LSGA "Design Guide".

4. SIGMA TM-3000 "Vertical Glazing Guidelines" and TB-3001 "Sloped Glazing Guidelines".

B. **Safety Glass:** Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.

C. **Insulating Glass Certification Program:** Provide insulating glass units permanently marked either on spacers or at least one component lite of units with appropriate certification label of Insulating Glass Certification Council (IGCC).

D. **Glazier Qualifications:** Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.

E. **Single-Source Responsibility for Glass:** Obtain glass from one source for each product indicated below:

1. Primary glass of each (ASTM C 1036) type and class indicated.

2. Heat-treated glass of each (ASTM C 1048) condition indicated.

3. Laminated glass of each (ASTM C 1172) kind indicated.

4. Insulating glass of each construction indicated.

F. **Single-Source Responsibility for Glazing Accessories:** Obtain glazing accessories from one source for each product and installation method indicated.

G. **Preconstruction Compatibility and Adhesion Testing:** Submit to sealant manufacturers samples of each glass, gasket, glazing accessory, and glass-framing member that will contact or affect glazing sealants for compatibility and adhesion testing as indicated below:

1. Use test methods standard with sealant manufacturer to determine if priming and other specific preparation techniques are required for rapid, optimum glazing sealants adhesion to glass and glazing channel substrates.

   a. Perform tests under normal environmental conditions during installation.

   b. Submit not less than 4 pieces of each type and finish of glass-framing members and each type, class, kind, condition, and form of glass (monolithic, laminated, insulating units) for adhesion testing, as well as

one sample of each glazing accessory (gaskets, setting, blocks and spacers) for compatibility testing.

c. Schedule sufficient time to test and analyze results to prevent delay in the progress of the Work.

d. Investigate materials failing compatibility or adhesion tests and obtain sealant manufacturer's written recommendations for corrective measures, including using special primers.

2. Testing is not required when glazing sealant manufacturer can submit required preparation data that is acceptable to Consultant and is based on previous testing of current sealant products for adhesion to and compatibility with submitted glazing materials.

H. **Pre-Installation Conference:** Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glass and glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, and other causes.

1. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator's recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. **Environmental Conditions:** Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing materials manufacturer or when glazing channel substrates are wet from rain, condensation, or other causes.

1. Install liquid sealants at ambient and substrate temperatures above 4 deg C.

1.9 WARRANTY

A. **General:** Warranties specified in this Article shall not deprive the Employer of other rights the Employer may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

B. **Manufacturer's Warranty on Laminated Glass:** Submit written warranty signed by laminated glass manufacturer agreeing to furnish replacements for laminated glass units that deteriorate as defined in Article 1.2, "Definitions", f.o.b. point of manufacture, freight allowed Project site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to glass manufacturer's published instructions.

1. Warranty Period: Manufacturer's standard, but not less than 5 years after date of Substantial Completion.

C. **Manufacturer's Warranty on Insulating Glass:** Submit written warranty signed by manufacturer of insulating glass agreeing to furnish replacements for insulating glass units that deteriorate as defined in Article 1.2, "Definitions", f.o.b. point of manufacture, freight allowed Project site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to

handling, installing, protecting, and maintaining practices contrary to glass manufacturer's published instructions.

1. Warranty Period: Manufacturer's standard, but not less than 10 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRIMARY FLOAT GLASS PRODUCTS

A. **Float Glass:** ASTM C 1036, Type I (transparent glass, flat), Class as indicated below, and Quality q3 (glazing select).

1. Class 1 (clear), for interior glass unless otherwise indicated.

2. Class 2 (tinted, heat-absorbing, and light-reducing), Arctic-Blue body-tinted.

B. **Translucent Glass:** Glass that transmits light with varying degrees of diffusion produced by sandblasting of surface of clear float as specified in Sub-Clause A of this Clause so that vision is not clear and light transmittance is lower than clear Glass. Requirements of translucent glass are to be similar to that of ASTM 1036-85, Type 2, Class 1.

2.2 HEAT-TREATED FLOAT GLASS

A. **Fabrication Process:** By horizontal (roller-hearth) process.

B. **Clear, Heat-Treated Float Glass:** ASTM C 1048, Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), kind as indicated below.

1. Kind FT (fully tempered).

2. Fully Tempered: Kind FT (fully tempered, having a minimum surface compression of 110,000 kPa (16,000 psi.).

3. "Roller distortion" and/or "ripples" shall run in the same direction for the entire Project. Glass shall be heat-treated through the use of a horizontal tempering furnace.

C. **Tinted, Heat-Treated Float Glass:** ASTM C 1048, Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 2 (tinted heat-absorbing and light-reducing), Quality q3 (glazing select), with tint color and performance characteristics for 6.0-mm-thick glass matching those indicated for annealed primary tinted float glass; kind as indicated below:

1. Kind FT (fully tempered) as indicated on Drawings and for the following applications:

a. Exterior lites of exterior double insulating glass units.

b. For low glazing (800mm and below) applications including lites of double insulating glass units. .

2.1 COATED FLOAT GLASS

A. **General:** Provide coated glass complying with requirements indicated in this Article.

B. Provide Kind FT (fully tempered) where safety glass is indicated.

C. **Low-e Coated Float Glass:** Float glass with solar-reflective metallic-oxide coating applied on surface #2 or surface #3 of the double insulating unit. Low-e coating shall be neutral color.

2.3 LAMINATED GLASS

A. **Laminated Glass:** Comply with ASTM C 1172, Kind LT (two lites of fully tempered Type 1 glass) and other requirements specified. Refer to primary and heat-treated glass requirements relating to properties of glass products comprising laminated glass products. Unless otherwise indicated, provide the following types of glass:

1. Laminated Glass 8.76 mm Thick Tinted/Clear:

   a. Outer Lite: Fully tempered, minimum 4.0 mm thick. Provide Arctic-Blue color tinted as selected by Consultant from manufacturer's standard colors to match existing.

   b. 2x0.38 mm PVB interlayer

   c. Inner Lite: Clear, fully tempered, minimum 4.0 mm thick.

2. Laminated Glass 13.50 mm Thick Clear/Clear:

   a. Outer Lite: Fully tempered, minimum 6.0 mm thick

   b. 4x0.38 mm PVB interlayer

   c. Inner Lite: Clear, fully tempered, minimum 6.0 mm thick

3. Laminated Glass 6.67 mm Thick Clear/Clear:

a. Outer Lite: Fully tempered, clear glass minimum 3.0 mm thick.

b. 2x0.38 mm PVB interlayer

c. Inner Lite: Clear, fully tempered, minimum 3.0 mm thick.

B. **Interlayer:** Interlayer material as indicated below, and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

1. Interlayer Material: Polyvinyl Butyral (PVB) sheets, clear, minimum thickness as indicated before.

C. **Laminating Process:** Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:

1. Laminate lites with polyvinyl butyral interlayer in autoclave with heat plus pressure.

2.4 INSULATING GLASS PRODUCTS

A. **Sealed Insulating Glass Units:** Preassembled units consisting of organically sealed lites of glass separated by dehydrated air spaces complying with ASTM E 774 and with other requirements indicated. Provide dual-seal sealing system, spacer material, dessicant, and corner construction as recommended by manufacturer, if not specified here after:

1. For properties of individual glass lites making up units, refer to requirements specified elsewhere in this Section applicable to types, classes, kinds, and conditions of glass products comprising lites of insulating glass units.

2. Construction of double insulating glass units Types G1 shall be as follows, unless otherwise indicated as Drawings.

   a. Outerboard lite: 8.76 mm thick laminated glass of silver/grey tinted\clear construction as specified.

   b. Air space: 19 mm thick. Provide stainless steel spacers and silica gel granules.

   c. Innerboard lite: 6.00 mm clear tempered glass. Interior lite shall be fully tempered safety glass for locations designated as hazardons locations in UBC section 2604.4 and for sill glazing (below 800 mm and below from adjoining flor level).

3. Performance Characteristics of Insulating Units shall be as follows:

   a. Transmittance, Visible Light: 20 percent.

   b. U-Value, Summer Daytime: 1.4 W/sq. m x Deg. C., maximum

   c. Shading Coefficient: 0.21, maximum

   d. STC: 42 db.

B. Double Insulating Units Type GL2:

1. Panel Make-Up:

   a. Outer Lite: 6.00 mm thick fully tempered of Arcatic-blue glass.

   b. Inter Space: 12.00 or 13.00 mm dehydrated air space.

   c. Inner Lite: 6.00 mm clear float glass. Interior lite shall be fully tempered safety glass for locations designated as hazardous locations in UBC section 2604.4 and for sill glazing (below 900 mm and below from adjoining floor level).

   d. Low-e Coating: Neutral low-e coating as specified on surface #2 or #3.

   e. Spacer:

      - Material: Stainless steel.

      - Desiccant: Molecular sieve or silica gel, or blend of both.

      - Corner Construction: Manufacturer's standard corner construction.

   Seals: Two-layer manufacturer’s standard seal system.

2. Thermal Performance

   Shading Coefficient 0.23 maximum.

   a. U-Value (Summer) 1.90 W/m2.k, maximum

   b. Relative Heat Gain: 160 W/m^2, maximum

3. Visible Light Performance .

   a. Light Transmittance 21%, minimum.

   b. Light Reflection (External): 19%, maximum

   c. Light Reflectance (Internal): 9%, maximum

4. Acoustical Performance:

   a. STC: 35

2.5 FIRE-RATED GLAZING PRODUCTS

A. **Laminated Glass with Intumescent Interlayers:** Proprietary product in the form of multiple lites of Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), annealed float glass laminated with intumescent interlayers; and as follows:

1. Fire-Protection Rating: As indicated for the assembly in which the glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to the Consultant.

2.6 FRAMELESS GLASS (ALL-GLASS) PARTITIONS

A. **Glass:** 12 mm thick fully tempered safety glass lites.

B. **Dimensions:** Comply with details indicated on Drawings.

C. **Edge Treatment:** Polished.

D. **Assembly Angles:** Stainless steel

E. **Fixation Systems:** Manufacturer's standard that comply with details indicated on Drawings and general requirements specified in Division 5, Section "Metal Fabrication" for materials and workmanship

F. **Base Covers:** Stainless steel base covers as specified in Division 5, Section "Formed Metal Fabrications"

G. **Fasteners and Anchors:** Stainless steel matching finish where exposed to view, zinc-plated steel where concealed

H. **Miscellaneous Materials:** Furnish complete with all necessary materials for fixing in place.

I. **Stainless Steel Components:** Alloy 304, satin finish.

2.7 ELASTOMERIC GLAZING SEALANTS

A. **General:** Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants and tapes of proven compatibility with other materials they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.

2. Suitability: Comply with sealant and glass manufacturer's recommendations for selecting glazing sealants and tapes that are suitable for applications indicated and conditions existing at time of installation.

3. Colors: Provide colors of exposed joint sealants as selected by Consultant from manufacturer's full range of standard colors for products of type indicated.

B. **Elastomeric Glazing Sealant Standard:** Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that comply with ASTM C 920 requirements for Type, Grade, Class and Uses.

2.8 GLAZING TAPES

A. **Back-Bedding Mastic Glazing Tape:** Preformed, butyl-based elastomeric tape with a solids content of 100 percent, nonstaining and nonmigrating in contact with nonporous surfaces, with or without spacer rod as recommended by tape and glass manufacturers for application indicated, packaged on rolls with a release paper backing, and complying with AAMA 800 for products indicated below:

1. AAMA 804.1.

2. AAMA 806.1.

3. AAMA 807.1.

B. **Expanded Cellular Glazing Tape:** Closed-cell, polyvinyl chloride foam tape, factory coated with adhesive on both surfaces, packaged on rolls with release liner protecting adhesive, and complying with AAMA 800 for Product 810.5.

2.9 GLAZING GASKETS

A. **Dense Compression Gaskets:** Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

1. EPDM, ASTM C 864.

B. **Soft Compression Gaskets:** Extruded or molded closed-cell, integral-skinned gaskets of material indicated below, complying with ASTM C 509, Type II, black, and of profile and hardness required to maintain watertight seal:

1. EPDM.

2.10 MISCELLANEOUS GLAZING MATERIALS

A. **General:** Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials involved for glazing application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. **Cleaners, Primers and Sealers:** Type recommended by sealant or gasket manufacturer.

C. **Setting Blocks:** Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.

D. **Spacers:** Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. **Edge Blocks:** Elastomeric material of hardness needed to limit glass lateral movement (side-walking).

F. **Plastic Foam Joint Fillers:** Preformed, compressible, resilient, nonstaining, nonextruding, nonoutgassing, strips of closed-cell plastic foam of density, size, and shape to control sealant depth and otherwise contribute to produce optimum sealant performance.

G. **Perimeter Insulation for Fire-Resistive Glazing:** Identical to product used in test assembly to obtain fire-resistive rating.

2.11 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standards as required to comply with specified performance requirements.

B. Glass Edges:

1. Exposed edges shall be ground and polished.

2. Butt glass edges shall be ground and polished.

3. All other edges shall have a high-quality factory-cut edge.

2.12 SPANDREL PANEL

A. **Spandrel Panels:** Are to comply with the following requirements and details indicated on Drawings

1. Box encasement: aluminum sheets of mill finish, 2.00 mm thick minimum.

2. Insulation: Foil-faced mineral fiber insulation as specified in Division 7, Section "Building Insulation".

3. Glass: To match outer lite of adjoining double insulating glass units as indicated on Drawings and specified with opicifier film on surface #2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine glass framing, with glazier present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.

2. Presence and functioning of weep system.

3. Minimum required face or edge clearances.

4. Effective sealing between joints of glass-framing members.

B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, except where more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions where indicated on Drawings provide minimum necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by referenced standards and Project conditions during installation.

C. Protect glass from edge damage during handling and installation as follows:

1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.

2. Remove damaged glass from Project site and legally dispose of off site. Damaged glass is glass with surface or edge damage or other imperfections that, when installed, weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install elastomeric setting blocks in sill rabbets, sized and located to comply with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass sizes larger than 1270 united mm (length plus height) as follows:

1. Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with specified performance requirements.

2. Provide 3-mm minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

L. Any glass lites installed within 900 mm from adjoining finish floor level (sill glazing) shall be marked as safety in compliance with standard referenced in this Section.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that when compressed by glass their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously but not in one continuous length. Do not stretch tapes to make them fit opening.

C. Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each lite is installed.

F. Where required, apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Where required, apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.

B. Secure compression gaskets in place with joints located at corners to compress gaskets producing a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

C. Install gaskets so they protrude from face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized gaskets to protrude slightly out of channel to eliminate dirt and moisture pockets.

3.7 GLASS PARTITIONS

A. Fix partitions firm in place indicated on Drawings at lines indicated, perfectly plumb without deviations from horizontal or vertical lines. Provide firm connections between glass lites of partitions and glass fins. All bolts and anchors shall be tightly screwed without overstressing glass. Use concealed EPDM washers and shims as required and comply with manufacturer's instructions.

3.8 PROTECTION AND CLEANING

A. Protect exterior glass from breakage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkali deposits, or stains, and remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents and vandalism, during construction period.

E. Wash glass on both faces in each area of Project not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass using materials and methods recommended by glass manufacturer.

SECTION 24: CEMENT PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Portland cement plaster.

2. Metal Lath suspended ceiling.

B. Related Sections: The following Sections contain Section:

1. Division 6 Section "Rough Carpentry".

Division 9 Section "Ceramic Tiles" for plaster base coat to be applied to receive ceramic wall tiles.

1.3 SUBMITTALS

A. **Product Data:** For each product specified.

B. **Samples for Initial Selection:** manufacturer's color charts consisting of actual units or sections of units at least 300 mm square showing the full range of colors, textures, and patterns available for each type of finish indicated.

1. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.

2. Include similar Samples of material for joints and accessories involving color selection.

C. **Shop Drawings:** Submit shop drawings for suspended metal lath ceilings including layout and details of ceilings installation

D. **Material Certificates:** certificate signed by manufacturer for each kind of plaster aggregate certifying that materials comply with requirements.

1.4 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Mockups:** Prior to installing plaster work, construct panels for each type of finish and application required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for

final unit of Work.

1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Consultant.
2. Erect mockups 1200 by 1200 mm by full thickness in presence of Consultant using materials, including lath, support system, and control joints, indicated for final Work.
3. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Consultant's approval of mockups before start of plaster Work.
6. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Portland cement plaster Work.
7. When directed demolish mockups, remove rubbles from site and replace with permanent works.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver cementitious materials to Project site in original packages, containers, or bundles, labeled with manufacturer's name, product brand name, and lot number.

B. Store materials indoor, under cover, and dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

1.6 PROJECT CONDITIONS

A. **Environmental Requirements, General:** Comply with requirements of referenced plaster application standards and recommendations of plaster manufacturer for environmental conditions before, during, and after plaster application.

B. **Warm-Weather Requirements:** Protect plaster against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial. Apply and cure plaster as required by climatic and job conditions to prevent dry out during cure period. Provide suitable coverings, moist curing, barriers to deflect sunlight and wind, or combinations of these, as required.

C. **Exterior Plaster Work:** Do not apply plaster when ambient temperature is below 4 deg C.

D. **Interior Plaster Work:** Maintain at least 10 deg C temperature in areas to be plastered for at least 48 hours before, during, and after application.

E. **Ventilation:** Provide natural or mechanical means of ventilation to properly dry interior spaces after Portland cement plaster has cured.

F. Protect contiguous work from soiling and moisture deterioration caused by plastering. Provide temporary covering and other provisions necessary to minimize harmful spattering of plaster on other work.

PART 2 - PRODUCTS

2.1 METAL SUPPORTS FOR SUSPENDED CEILINGS

A. **General:** Size metal ceiling supports to comply with ASTM C 1063, unless otherwise indicated.

B. **Postinstalled Anchors in Concrete:** Anchors of type indicated below, fabricated from corrosion-resistant materials, with holes or loops for attaching hanger wires; and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing according to ASTM E 488 conducted by a qualified independent testing agency.

1. Chemical anchor.

C. **Wire for Hangers and Ties:** ASTM A 641 M, Class 1 zinc coating, soft temper.

D. **Rod Hangers:** Mild steel, zinc coated.

E. **Flat Hangers:** Mild steel, zinc coated or protected with rust-inhibitive paint.

F. **Channels:** Cold-rolled steel, minimum 1.5-mm- thick base (uncoated) metal and 11.1-mm- wide flanges, and as follows:

1. Carrying Channels: Based on design calculations but not less than 38 mm deep, 0.7 kg/m.

G. **Finish:** ASTM A 653M, Z180 hot-dip galvanized coating for framing where indicated.

2.2 LATH

A. **Expanded-Metal Lath:** Comply with ASTM C 847 for material, type, configuration, and other characteristics indicated below.

1. Material: Fabricate expanded-metal lath from sheet metal conforming to the following:

a. Galvanized Steel: Structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A 653M, Z275 minimum coating designation, unless otherwise indicated.

b. Form: Coil.

c. Special Pieces: For internal corners.

2. Diamond-Mesh Lath for Plaster Background: Comply with the following requirements:

a. Configuration: Flat.

1) i. Weight: 1.1 kg/sq. m.

3. Rib Lath for Suspended Ceilings: Comply with the following requirements:

a. Configuration: Flat, rib depth of not over 3 mm.

1) Weight: 1.8 kg/sq. m.

2.3 ACCESSORIES

A. **General:** Comply with material provisions of ASTM C 1063 and the requirements indicated below; coordinate depth of accessories with thicknesses and number of plaster coats required.

1. Galvanized Steel Components (for internal plaster): Fabricated from zinc-coated (galvanized) steel sheet complying with ASTM A 653M, Z90 minimum coating

designation.

B. **Metal Corner Reinforcement:** Expanded, large-mesh, diamond-metal lath fabricated from zinc-alloy or welded-wire mesh fabricated from 1.2-mm- diameter, zinc-coated (galvanized) wire and specially formed to reinforce external corners of Portland cement plaster on exterior exposures while allowing full plaster encasement.

C. **Cornerbeads:** Small nose cornerbeads fabricated from the following metal, with expanded flanges of large-mesh diamond-metal lath allowing full plaster encasement.

D. **Casing Beads:** Square-edged style, with expanded flanges.

E. **Curved Casing Beads:** Square-edged style, fabricated from aluminum coated with clear plastic, preformed into curve of radius indicated.

F. **Control Joints:** Prefabricated, of material and type indicated below:

1. One-Piece Type: Folded pair of nonperforated screeds in M-shaped configuration, with expanded or perforated flanges.

2. Two-Piece Type: Pair of casing beads with back flanges formed to provide slip-joint action, adjustable for joint widths from 3 to 16 mm.

a. Provide removable protective tape on plaster face of control joints.

G. **Foundation Sill (Weep) Screed:** Manufacturer's standard profile designed for use at sill plate line to form plaster stop and prevent plaster from contacting damp earth, fabricated from zinc-coated (galvanized) steel sheet.

H. **Lath Attachment Devices:** Material and type required by ASTM C 1063 for installations indicated.

2.4 PLASTER MATERIALS

A. **Base-Coat Cements:** Type as indicated below:
1. Portland cement, ASTM C 150, Type I.

B. **Job-Mixed Finish-Coat Cement**: Material and color as indicated below:

1. Portland cement: sand aerated mix

C. **Cement Color:** Gray.

D. **Lime:** do not use lime.

E. **Plasticiser:** ASTM C260.

F. **Sand Aggregate for Base Coats:** ASTM C 897.

G. **Aggregate for Finish Coats:** ASTM C 897 system and as indicated

below: 1. Manufactured or natural sand, White in color.

2.5 MISCELLANEOUS MATERIALS

A. **Fiber for Base Coat:** Alkaline-resistant glass or polypropylene fibers, 13 mm long, free of contaminates, manufactured for use in Portland cement plaster.

B. **Water for Mixing and Finishing Plaster:** Potable.

C. **Acid-Etching Solution:** Muriatic acid (10 percent solution of commercial hydrochloric acid) mixed 1 part to not less than 6 nor more than 10 parts water.

D. **Dash-Coat Material:** 2 parts Portland cement to 3 parts fine sand, mixed with water to a mushy-paste consistency.

2.6 PLASTER MIXES AND COMPOSITIONS

A. **General:** Comply with ASTM C 926 for base- and finish-coat mixes as applicable to plaster bases, materials, and other requirements indicated. Do not use lime in plaster mixes.

B. **Base-Coat Mixes and Compositions:** Proportion materials for respective base coats in parts by volume per sum of cementitious materials for aggregates to comply with the following requirements for each method of application and plaster base indicated. Adjust mix proportions below within limits specified to attain workability.

C. **Fiber Content:** Add fiber to following mixes after ingredients have mixed at least 2 minutes. Comply with fiber manufacturer's written instructions but do not exceed 16 kg/cu. m of cementitious materials. Reduce aggregate quantities accordingly to maintain workability.

D. **Three-Coat Work over Metal Lath:** Base-coat proportions as indicated below:

1. Scratch Coat: 1 part Portland cement, 2-1/2 to 4 parts aggregate.

2. Brown Coat: 1 part Portland cement, 3 to 5 parts aggregate.

3. Admixtures and workability aids, as per manufacturer’s printed instructions

E. **Two-Coat Work over Concrete and Concrete Unit Masonry:** Base-coat proportions as indicated below:

1. Base Coat: 1 part Portland cement, 5 parts aggregate, aerating plasticiser as per manufacturer’s recommendation.

F. **Job-Mixed Finish Coats:** Proportion materials for finish coats in parts by volume for cementitious materials and parts by volume per sum of cementitious materials to comply with the following requirements:

1. Proportions using sand aggregates as indicated below:

a. 1 part Portland cement, 4 parts aggregate, aerating plasticiser as per manufacturer’s recommendation.

2.7 MIXING

A. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION OF CEILING SUSPENSION SYSTEMS

A. **Preparation and Coordination:** Coordinate installation of ceiling suspension

system with installation of overhead structural systems to ensure inserts and other structural anchorage provisions have been installed to receive ceiling hangers in a manner that will develop their full strength and at spacings required to support ceiling.

B. **Hanger Installation:** Attach hangers to structure above ceiling to comply with ML/SFA 920, "Guide Specifications for Metal Lathing and Furring," and with referenced standards.

C. Install ceiling suspension system components of sizes and spacings indicated, but not in smaller sizes or greater spacings than those required by referenced lathing and furring installation standards.

1. Wire Hangers: Space 4-mm- diameter wire hangers not over 1200 mm o.c., parallel with and not over 900 mm perpendicular to direction of carrying channels, unless otherwise indicated, and within 150 mm of carrying channel ends.

2. Carrying Channels: Space carrying channels not over 900 mm o.c. with 1200-mm o.c. hanger spacing.

3. Furring Channels to Receive Metal Lath: Space furring channels not over 500 mm o.c. for 1.8-kg/sq. m flat rib lath.

3.2 PREPARATIONS FOR PLASTERING

A. Clean plaster bases and substrates for direct application of plaster, removing loose material and substances that may impair the Work.

B. Etch concrete and concrete unit masonry surfaces indicated for direct plaster application. Scrub with acid-etching solution on previously wetted surface and rinse thoroughly with clean water. Repeat application, if necessary, to obtain adequate suction and mechanical bond of plaster (where dash coat, bonding agent, or additive is not used).

C. **Dissimilar Backgrounds:** where rendering is to be continued without break across joints between dissimilar solid backgrounds which are in the same plane and rigidly bonded or tied together, cover joints with 150mm wide strip of building paper overlaid with 300mm wide galvanized steel lathing fixed with corrosion resistant fasteners at not more than 600mm centers along both edges.

D. Apply dash coat on concrete and concrete masonry surfaces indicated for direct plaster application. Moist-cure dash coat for at least 24 hours after application and before plastering.

E. Install temporary grounds and screeds to ensure accurate rodding of plaster to true surfaces; coordinate with scratch-coat work.

F. Refer to Division 6 Sections for installing permanent wood grounds, if any.

G. **Surface Conditioning:** Immediately before plastering, dampen concrete and concrete unit masonry surfaces that are indicated for direct plaster application. Determine and apply amount of moisture and degree of saturation that will result in optimum suction for plastering.

3.3 LATHING

A. Install metal lath for the following applications where plaster base coats are required. Provide appropriate type, configuration, and weight of metal lath selected

from materials indicated that comply with referenced ML/SFA specifications and ASTM lathing installation standards.

1. Dissimilar Backgrounds: where rendering is to be continued without break across joints between dissimilar solid backgrounds which are in the same plane and rigidly bonded or tied together, cover joints with 150 mm wide strip of building paper overlaid with 300 mm wide galvanized steel lathing fixed at not more than 600 mm centers along both edges.

3.4 INSTALLATION OF PLASTERING ACCESSORIES

A. **General:** Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and in alignment during plastering. Install accessories of type indicated at following locations:

1. External Corners: Install corner reinforcement at external corners.
2. Terminations of Plaster: Install casing beads, unless otherwise indicated.
3. Control Joints: Install at locations indicated or, if not indicated, at locations complying with the following criteria and approved by Consultant:
    a. Where an expansion or contraction joint occurs in surface of construction directly behind plaster membrane.
    b. Distance between Control Joints: Not to exceed 5.5 m in either direction or a length-to-width ratio of 2-1/2 to 1.
    c. Wall Areas: Not more than 13 sq. m.
    d. Horizontal Surfaces: Not more than 9 sq. m in area.
    e. Where plaster panel sizes or dimensions change, extend joints full width or height of plaster membrane.

3.5 PLASTER APPLICATION

A. **Plaster Application Standard:** Apply plaster materials, composition, and mixes to comply with ASTM C 926.

B. Do not use materials that are frozen, caked, lumpy, dirty, or contaminated by foreign materials.

C. Do not use excessive water in mixing and applying plaster materials.

D. **Flat Surface Tolerances:** Do not deviate more than plus or minus 3 mm in 3 m from a true plane in finished plaster surfaces, as measured by a 3-m straightedge placed at any location on surface.

E. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, and before lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 150 mm at each jamb anchor.

F. **Sequence plaster** application with installation and protection of other work so that neither will be damaged by installation of other.

G. Plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where interior plaster is not terminated at metal frame by casing beads, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.

H. **Corners:** Make internal corners and angles square; finish external corners flush with corner beads on interior work, square and true with plaster faces on exterior work.

I. **Finish Coats:** Apply finish coats to comply with the following requirements:

1. Float Finish: Apply finish coat to a minimum thickness of 3 mm to completely cover base coat, uniformly floated to a true even plane with fine-textured finish matching samples approved by the Consultant.

J. **Number of Coats and Thickness:** Excluding dash coats and dubbing out coats apply plaster of composition indicated, to comply with the following requirements:

1. Two Coats: Base and finish coats over the following plaster bases:

a. Concrete unit masonry.

b. Concrete, cast-in-place or precast when surface condition complies with ASTM C 926 for plaster bonded to solid base.

2. Three Coats: Scratch, base and finish coats over metal lath backgrounds and installations.

3. Overall thickness is to be 15.00 mm for internal plaster and 20.00 mm for external plaster.

4. One plaster base coat (15 mm thick) for walls to be finished with ceramic tiles set with thin bed adhesive.

5. One coat work (15 mm thick) for plaster on concrete structural slabs uniformly floated to a true even plane

K. Moist-cure plaster base and finish coats to comply with ASTM C 926, including written instructions for time between coats and curing in "Annex A2 Design Considerations."

3.6 CUTTING AND PATCHING

A. Cut, patch, replace, repair, and point up plaster as necessary to accommodate other work. Repair cracks and indented surfaces. Point-up finish plaster surfaces around items that are built into or penetrate plaster surfaces. Repair or replace work to eliminate blisters, buckles, check cracking, dry outs, efflorescence, excessive pinholes, and similar defects. Repair or replace work as necessary to comply with required visual effects.

3.7 CLEANING AND PROTECTING

A. Remove temporary covering and other provisions made to minimize spattering of plaster on other work. Promptly remove plaster from doorframes, windows, and other surfaces not to be plastered. Repair surfaces stained, marred or otherwise damaged during plastering work. When plastering work is completed, remove unused materials, containers, equipment, and plaster debris.

B. Provide final protection and maintain conditions, in a manner acceptable to Consultant, that ensure plaster work is without damage or deterioration at the time of Substantial Completion.

SECTION 25 - GYPSUM BOARD ASSEMBLIES PART

1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Suspended gypsum board ceilings.
2. Gypsum board walls and partitions.
3. Recessed Lighting enclosure.
4. Partition Closers.
5. Framed steelwork encasement.

B. **Related Sections:** The following Sections contain requirements that relate to this Section:

1. Division 5 Section”Metal Fabrication”.
2. Division 6 Section "Rough Carpentry" for wood framing and furring, and gypsum sheathing applied over wood framing.
3. Division 7 Section "Through-Penetration Firestop Systems" for firestopping systems and fire-resistance-rated joint sealants.
4. Division 8 Section "Custom Steel Doors and Frames" for steel door to be installed in gypsum board walls or partitions.

1.3 DEFINITIONS

A. **Gypsum Board Construction Terminology:** Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 ASSEMBLY PERFORMANCE REQUIREMENTS

A. **Fire Resistance Characteristics:** Provide interior gypsum board assemblies with fire-resistance ratings indicated.

1.5 SUBMITTALS

A. **Product Data:** For each type of product specified.

B. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of Consultants and Employers, and other any information required by the Consultant.

C. **Shop Drawings:** Showing locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.

D. **Samples:** For the following products:

1. Trim Accessories: Full-size sample in 300-mm-long length for each trim accessory indicated.

2. Access panel framing and hardware

E. **Product Certificates:** Signed by manufacturers of gypsum board assembly components certifying that their products comply with specified requirements.

F. **Installer Certificates:** Signed by the product manufacturer certifying that the Installer is approved, authorized, or licensed by the manufacturer to install his products.

G. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer's representative.

1.6 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Installer Qualifications:** A qualified firm specializing in performing the work of this Section with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product and that is eligible to receive manufacturer's warranty. Include project names and addresses, names and addresses of Consultants and Employers, and other information specified

C. **Single-Source Responsibility for Gypsum Boards and Steel Framing:** Obtain each type of gypsum board and other panel products and steel framing from a single manufacturer.

D. **Single-Source Responsibility for Finishing Materials:** Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable t the gypsum board manufacturer.

E. **Fire-Test-Response Characteristics:** Where fire-resistance-rated gypsum board assemblies are indicated, provide gypsum board assemblies that comply with the following requirements:

1. Gypsum board assemblies indicated are identical to assemblies tested for fire resistance according to ASTM E 119 or BS 476 Part 20-24by an independent testing and inspecting agency acceptable to the Consultant.
2. Deflection and Firestop Track: Top runner provided in fire-resistance-rated assemblies indicated is labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to the Consultant.

F. **Mockups:** Prior to finishing gypsum board assemblies, construct mockups of at least 9 sq. m in surface area to demonstrate aesthetic effects of finishes as well as qualities of materials and execution. Simulate finished lighting conditions for review of in-place unit of Work.

1. Construct mockups for each of the following applications:

a. Ceiling surfaces indicated to receive emulsion paint finishes.

2. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.

   a. Locate mockups on site in the location and of the size indicated or, if not indicated, as directed by the Consultant.

   b. Notify the Consultant one week in advance of the dates and times when mockups will be constructed.

   c. Demonstrate the proposed range of aesthetic effects and workmanship.

   d. Obtain the Consultant's approval of mockups before start of final unit of Work.

   e. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

   f. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

C. Handle steel framing materials in a manner not to cause bending or denting of sections.

1.8 PROJECT CONDITIONS

A. **Environmental Conditions, General:** Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.

B. **Room Temperatures:** Maintain room temperature at not less than 4 deg. C.

C. **Ventilation:** Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 STEEL FRAMING COMPONENTS FOR SUSPENDED CEILINGS

A. **General:** Provide components complying with ASTM C 754 for conditions indicated.

B. **Post-installed Anchors in Concrete:** Anchors of type indicated below, fabricated from corrosion-resistant materials, with holes or loops for attaching hanger wires, and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing according to ASTM E 488 conducted by a qualified independent testing agency.

   1. Expansion anchor.

C. **Wire Ties:** ASTM A 641 M, Class 1 zinc coating, soft temper, 1.6 mm thick.

D. **Hanger Rods:** Mild steel and zinc coated or protected with rust-inhibitive paint.

E. **Flat Hangers:** Mild steel and zinc coated or protected with rust-inhibitive paint.

F. **Angle-Type Hangers:** Angles with legs not less than 22.2 mm wide, formed from 1.6-mm- thick galvanized steel sheet complying with ASTM A 653M, Z 180 coating designation, with bolted connections and 8 mm diameter bolts.

G. **Channels:** Cold-rolled steel, 1.5 mm minimum thickness of base (uncoated) metal and 11.1 mm wide flanges, and as follows:

1. Carrying Channels: 38 mm deep, 70 kg/100 m, unless otherwise indicated.

2. Furring Channels: 19 mm deep, 45 kg/100 m, unless otherwise indicated.

3. Finish: ASTM A 653M, Z 180 hot-dip galvanized coating.

2.2 STEEL FRAMING FOR WALLS AND PARTITIONS

A. **General:** Provide steel framing members complying with the following requirements:

1. Protective Coating: ASTM A 653M, Z180 hot-dip galvanized corrosion resistant coating.

B. **Steel Studs and Runners:** ASTM C 645, with flange edges of studs bent back 90 degrees and doubled over to form 5 mm wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness: 0.84 mm as follows:

a. For head runner, sill runner, jamb, and cripple studs at door and other openings.

b. Where indicated.

2. Depth: As required to obtain thickness indicated on Drawings.

C. **Deflection Track:** Manufacturer's standard top runner designed to prevent cracking of gypsum board applied to interior partitions resulting from deflection of the structure above fabricated from steel sheet complying with ASTM A 653M or ASTM A 568M. Thickness as indicated for studs, and width to accommodated depth of studs, and of the following configuration:

1. Top Runner with Compressible Flanges: 64 mm deep flanges with V-shaped offsets that compress when pressure is applied from construction above.

2. Top Runner with Slotted Flanges: 64 mm deep flanges with slots 25 mm o.c.

3. Top runner with 64 mm deep flanges that either have V-shaped offsets that compress when pressure is applied from construction above or have slots 25 mm o.c. that allow fasteners attached to studs through the slots to accommodate structural movement by slipping.

D. **Deflection and Firestop Track For Fire Rated Assemblies:** Top runner designed to allow partition heads to expand and contract with movement of structure above while maintaining continuity of the assembly. Comply with requirements of ASTM C

645 except configuration, of thickness indicated for studs and width to accommodate depth of studs indicated with flanges offset at midpoint to accommodate gypsum board thickness.

1. Offset Configuration: Shadow-line design with offset projecting out from depth of stud.

2. Offset Configuration: Reveal design with offset recessing in from depth of stud.

E. **Steel Rigid Furring Channels:** ASTM C 645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:

1. Thickness: 0.84 mm, unless otherwise indicated.

2. Depth: 22.2 mm.

F. **Furring Brackets:** Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.84 mm, designed for screw attachment to steel studs and steel rigid furring channels used for furring.

G. **Steel Resilient Furring Channels:** Manufacturer's standard product designed to reduce sound transmission, fabricated from steel sheet complying with ASTM A 653M or ASTM A 568M to form 13 mm deep channel of the following configuration:

1. Single-Leg Configuration: Asymmetric-shaped channel with face connected to a single flange by a single-slotted leg (web).

2. Double-Leg Configuration: Hat-shaped channel with 38 mm wide face connected to flanges by double-slotted or expanded-metal legs (webs).

H. **Z-Furring Members:** Manufacturer's standard Z-shaped furring members with slotted or nonslotted web, fabricated from steel sheet complying with ASTM A 653M or ASTM A 568M; with a minimum base metal (uncoated) thickness of 0.45 mm, face flange of 31.8 mm, wall-attachment flange of 22.2 mm, and of depth required to fit insulation thickness indicated.

I. **Steel Channel Bridging:** Cold-rolled steel, 1.5 mm minimum thickness of base (uncoated) metal and 11.1 mm wide flanges, 38 mm deep, 45 kg/100 m, unless otherwise indicated.

J. **Steel Flat Strap and Backing Plate:** Steel sheet for blocking and bracing complying with ASTM A 653M or ASTM A 568M, length and width as indicated, and with a minimum base metal (uncoated) thickness as follows:

1. Thickness: 1.5 mm where indicated.

2.3 Fasteners for Metal Framing: Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.

2.4 GYPSUM BOARD PRODUCTS

A. **General:** Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.

1. Widths: Provide gypsum board in widths of 1200 mm.

2. Composition: The mix for manufacture of gypsum boards shall incorporate reinforcing noncombustible glass fibers.

B. **Gypsum Wallboard:**

1. ASTM C 36 and as follows: Type: Regular, unless otherwise indicated for lining.

2. Type: Type X where required for fire-resistance-rated assemblies.

3. Type: Sag-resistant type for ceiling surfaces.

4. Edges: Tapered.

5. Thickness: 13 mm, unless otherwise indicated and unless higher thickness is recommended by manufacturer to obtain fire performance rating specified.

C. **Water-Resistant Gypsum Backing Board:** ASTM C 630 and as follows:

1. Type: Regular, unless otherwise indicated.

2. Type: Type X where required for fire-resistance-rated assemblies and where indicated.

3. Type: Sag-resistant type for ceiling surfaces.

4. Thickness: 13 mm, unless otherwise indicated and unless higher thickness is recommended by manufacturer to obtain fire performance rating specified.

5. Use for application in wet areas and where indicated on Drawings or specified.

2.5 TRIM ACCESSORIES

A. **Accessories for Interior Installation:** Cornerbead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:

1. Material: Formed metal or plastic, with metal complying with the following requirement:

   a. Steel sheet zinc coated by hot-dip, G60 (Z180) coating intensity.

2. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:

   a. Cornerbead on outside corners, unless otherwise indicated.

   b. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.

   c. L-bead with face flange only; face flange formed to receive joint compound. Use L-bead where indicated.

   d. U-bead with face and back flanges; face flange formed to be left without application of joint compound. Use U-bead where indicated.

   e. One-piece control joint formed with V-shaped slot and removable strip covering slot opening.

2.6 JOINT TREATMENT MATERIALS

A. **General:** Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

B. **Joint Tape for Gypsum Board:** Use open-weave, glass-fiber reinforcing tape, 50 mm wide with compatible joint compound where recommended by the manufacturer of gypsum board and joint treatment materials for application indicated.

C. **Drying-Type Joint Compounds for Gypsum Board:** Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.

1. Ready-Mixed Formulation: Factory-mixed product.

a. All-purpose compound formulated for both taping and topping compounds.

2.7 ACOUSTICAL SEALANT

A. **Acoustical Sealant for Exposed and Concealed Joints:** Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:

1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

B. **Acoustical Sealant for Concealed Joints:** Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

2.8 MISCELLANEOUS MATERIALS

A. **General:** Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.

B. Steel drill screws complying with ASTM C 1002 for the following applications:

1. Fastening gypsum board to steel members less than 0.84 mm thick.

C. Steel drill screws complying with ASTM C 954 for fastening gypsum board to steel members from 0.84 to 2.84 mm thick.

D. Steel drill screws of size and type recommended by unit manufacturer for fastening cementitious boards.

E. **Foam Gaskets:** Closed-cell vinyl foam adhesive-backed strips that allow fastener penetration without foam displacement, 3.2 mm thick, in width to suit metal stud size indicated.

F. **Sound-Attenuation Blankets:** Unfaced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).

1. Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.

2. Blanket is to be 40 mm thick, 60 kg/m3 intensity, minimum.

3. Where ceiling plenum is used for air condition return, use sound blanket with foil scrim facing and set with facing at upper side in the as-installed position.

G. **Core Material:** Material indicated below, of thickness and width to fill inner cavity of gypsum board wall or partition.

1. Unfaced Mineral-Fiber Blanket Insulation: Unfaced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).

a. Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.

b. Intensity: As recommended by manufacturer to attain performance specified.

2. Manufacturer's standard pre-packed mineral fiber insulation quilts to be snugly fitted in vertical studs.
a. Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.

b. Intensity: As recommended by manufacturer to attain performance specified.

H. **Vapor Retarder Tape:** Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder. Use at warm side of open-to-air assemblies.

2.9 RECESSED LIGHTING ENCLOSURE

A. Shall be constructed from 13.00 mm thick plasterboards, moisture-resistant type, fixed to galvanized steel furring channels not less than 0.84 mm thick with galvanized steel plasterboard screws

B. Lighting Enclosure shall also comprise stainless steel, alloy 304, grille of polished mirror finish loosely laid on stainless steel T-section supports of material and finish matching that of the adjoining suspended ceiling. Comply with applicable requirements of Division 5, Section "Metal Fabrications" for manufacture of grilles.

C. Inner surfaces of plasterboards are to receive smooth acrylic emulsion paint finish of White color, as specified in Division 9, Section "Painting".

2.10 PARTITIONS CLOSERS

A. **Partition Closers:** Are nonload-bearing gypsum boards short solid partitions used to close the gabs between masonry walls and partitions and aluminum used in building elevations.

B. **Fire Rating:** Partition closer is to be of the same fire resisting rating as of the masonry wall or partition to which it is fixed.

2.11 FRAMED STEELWORK ENCASEMENT

A. System:

1. Fire rated gypsum boards as specified fixed to lightweight framework connected to structural steel work with manufacturer's standard clips.
2. Manufacturer's standard patent system that is tested and list for fire protection ratings indicated on Drawings and recommended by manufacturers for steel

sections and applications indicated.

B. **Framework:** Fabricated from galvanized steel sheets, not less than 180 gm/m2 zinc coating intensity. Clips and fasteners or anchors are to be from galvanized steel of same minimum zinc coating intensity.

C. **Joints**: Tape and finish using manufacture's jointing compounds used in laboratory fire testing of the system.

D. Where necessary, use moisture resistant fire rated gypsum boards.

E. **Fire** Protections Rating: As indicated on Fire Drawings.

F. Use of Frameless steelwork encasement is not acceptable.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with the Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. **Ceiling Anchorages:** Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

B. Before sprayed-on fireproofing is applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed-on fireproofing. Where offset anchor plates are required, provide continuous units fastened to building structure not more than 600 mm o.c.

C. After sprayed-on fireproofing has been applied, remove only as much fireproofing as needed to complete installation of gypsum board assemblies without reducing thickness of fireproofing below that is required to obtain fire-resistance rating indicated. Protect remaining fireproofing from damage.

3.3 INSTALLING STEEL FRAMING, GENERAL

A. **Steel Framing Installation Standard:** Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with United States Gypsum Co.'s "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.

1. Where building structure abuts ceiling perimeter or penetrates ceiling.

2. Where lining abut structure, except at floor.

a. Provide cushioned-type joints as detailed to attain lateral support

and avoid axial loading.

D. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members as indicated.

3.4 INSTALLING STEEL FRAMING FOR SUSPENDED CEILINGS

A. Suspend ceiling hangers from building structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.

4. Secure flat, angle, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye-screws, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or otherwise fail.

5. Do not support ceilings directly from permanent metal forms. Furnish cast-in place hanger inserts that extend through forms.

6. Do not attach hangers to steel deck tabs.

7. Do not attach hangers to steel roof deck. Attach hangers to structural members.

8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Sway-brace suspended steel framing with hangers used for support.

C. Install suspended steel framing components in sizes and at spacings recommended by manufacturer, but not less than that required by the referenced steel framing installation standard.

1. Wire Hangers: 1200 mm o.c.

2. Carrying Channels (Main Runners): 1200 mm o.c.

3. Furring Channels (Furring Members): 400 mm o.c.

D. **Installation Tolerances:** Install steel framing components for suspended ceilings so that cross-furring or grid suspension members are level to within 3 mm in 3.6 m as

measured both lengthwise on each member and transversely between parallel members.

E. Wire-tie or clip furring members to main runners and to other structural supports as indicated.

3.5 INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS

A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.

1. Where studs are installed directly against exterior walls, install asphalt felt strips or foam gaskets between studs and wall.

2. Additional Runners and Furring: Where fittings, equipment or accessories are to be hung to gypsum board walls or partitions, provide additional runners or furring of suitable section and wall thickness installed at locations so as to receive fasteners of fittings, equipment or accessories. Coordinate with Drawings or shop drawings indicating work items to be hung to gypsum board walls or partitions.

B. **Installation Tolerances:** Install each steel framing and furring member so that fastening surfaces do not vary more than 3 mm from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height from structural floors to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. Cut studs 13 mm short of full height to provide perimeter relief.

2. For fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid structural surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed, to support gypsum board closures needed to make partitions continuous from floor to underside of solid structure.

D. Install steel studs and furring in sizes and at spacings indicated.

1. Single-Layer Construction: Space studs 400 mm o.c., unless otherwise indicated.

2. Multilayer Construction: Space studs 600 mm o.c., unless otherwise indicated.

E. Install steel studs so that flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.

F. Frame door openings to comply with GA-219, and with applicable published recommendations of the gypsum board manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Install 2 studs at each jamb, unless otherwise indicated.

2. Install cripple studs at head adjacent to each jamb stud, with a minimum 13

mm clearance from jamb stud to allow for installation of control joint.

3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.

G. Frame openings other than door openings to comply with details indicated or, if none indicated, as required for door openings. Install framing below sills of openings to match framing required above door heads.

H. Install insulation to manufacturer's standard details approved by the Consultant.

I. Install polyethylene vapor retarder where indicated to comply with the following requirements:

1. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with mechanical fasteners or adhesives. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose mineral-fiber insulation.

2. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 400 mm o.c.

3. Seal joints in vapor retarders caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor retarder tape.

4. Repair any tears or punctures in vapor retarder immediately before concealing it with the installation of gypsum board or other construction.

3.6 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. **Gypsum Board Application and Finishing Standards:** Install and finish gypsum panels to comply with ASTM C 840 and GA-216.

B. Install sound-attenuation blankets, where indicated, prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1.5 mm of open space between panels. Do not force into place.

E. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Avoid joints other than control joints at corners of framed openings where possible.

F. Attach gypsum panels to steel studs so that leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. Attach gypsum panels to framing provided at openings and cutouts.

H. Form control and expansion joints at locations indicated and as detailed, with space between edges of adjoining gypsum panels, as well as supporting framing behind gypsum panels.

I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases that are braced internally.

1. Except where concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 0.7 sq. m in area.

2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 6.5 to 9.5 mm wide joints to install sealant.

J. Isolate perimeter of nonload-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 6.5 to 13 mm wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.

1. Space screws a maximum of 300 mm o.c. for vertical applications.

2. Space screws a maximum of 200 mm o.c. for ceilings.

L. Space fasteners in panels that are tile substrates a maximum of 200 mm o.c.

3.7 GYPSUM BOARD APPLICATION METHODS

A. **Single-Layer Application:** Install gypsum wallboard panels as follows:

1. On ceilings, apply gypsum panels prior to wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.

2. On partitions/walls, unless otherwise indicated, and provide panel lengths that will minimize end joints.

3. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless parallel application is required for fire-resistance-rated assemblies. Use maximum-length panels to minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of board.

b. At stairwells and other high walls, install panels horizontally.

B. **Multilayer Application on Partitions/Walls:** Apply gypsum board indicated for base layers and gypsum wallboard face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints. Stagger joints on opposite sides of partitions.

1. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge

joints of base layer over furring members.

C. **Single-Layer Fastening Methods:** Apply gypsum panels to supports as follows:

1. Fasten with screws.

3.8 INSTALLING TRIM ACCESSORIES

A. **General:** For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.

B. Install corner-bead at external corners.

C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.

1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.

2. Install L-bead where edge trim can only be installed after gypsum panels are installed.

3. Install U-bead where indicated.

4. Install aluminum trim and other accessories where indicated.

D. Install control joints at locations indicated.

E. Install control joints according to ASTM C 840 and manufacturer's recommendations and in specific locations approved by the Consultant for visual effect.

3.9 FINISHING GYPSUM BOARD ASSEMBLIES

A. **General:** Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.

B. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.

C. Apply joint tape over gypsum board joints and to flanges of trim accessories as recommended by the trim accessory manufacturer.

D. **Levels of Gypsum Board Finish:** Provide the following levels of gypsum board finish per GA-214.
1. Level 5.

E. Use one of the following joint compound combinations as applicable to the finish levels specified.

F. Where Level 5 gypsum board finish is indicated, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories; and apply a thin, uniform skim coat of joint compound over entire surface. For skim coat, use joint compound specified for third coat, or a product specially formulated for this purpose and acceptable to the gypsum board manufacturer. Touch up and sand between coats and after last coat

as needed to produce a surface free of visual defects, tool marks, and ridges and ready for decoration.

3.10 FIELD QUALITY CONTROL

A. **Above-Ceiling Observation:** The Consultant will conduct an above-ceiling observation prior to installation of gypsum board ceilings and report any deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.

1. Notify the Consultant one week in advance of the date and the time when the Project, or part of the Project, will be ready for an above-ceiling observation.

2. Prior to notifying the Consultant, complete the following in areas to receive gypsum board ceilings:

   a. Installation of 80 percent of lighting fixtures, powered for operation.

   b. Installation, insulation, and leak and pressure testing of water piping systems.

   c. Installation of air duct systems.

   d. Installation of air devices.

   e. Installation of mechanical system control air tubing.

   f. Installation of ceiling support framing.

3.11 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner acceptable to the Installer, that ensure that gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.

SECTION 26 – STONE SOLING

1. SCOPE

The work under this section of specifications consists of furnishing all plant, labour, equipment, appliances, materials and performance of all operations required in connection with the construction of stone soling in strict accordance with the specifications and Drawings and/or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. STONE

Stone to be used shall comprise of strong, hard, durable stone of the approved size, free from impurities, quarry sap, dust, dirt and solubility characteristics. The stone shall be obtained from approved quarries and shall be sound, free from laminations and weak cleavages.

3. CONSTRUCTION

3.1 Preparation of Sub-grade

Sub-grade shall be formed of suitable materials free of clods, sod, roots, stumps, brush or other objectionable material.

Sub-grade material shall be placed in successive layers not exceeding 6 inch in thickness and each layer shall be thoroughly compacted at optimum moisture content.

The maximum dry weight density of the sub-grade shall not be less than 95% of Modified AASHTO requirements.

3.2 Stone Ballast Soling

The Stone Ballast shall be well graded and broken hard of 3" mesh obtained from an approved quarry.

The stone shall be laid and packed to even grades and well rolled using vibratory roller/plate compactor to a consolidated thickness of not less than 6 inch or as shown on the Drawings.

The whole of the surface of the compacted stone ballast soling will be blinded with morum or any other approved gritty material done dust (Khaka). After the interstices have been filled with smaller size crushed stone, so as to effectively fill in the voids and crevices, soling area may be watered, if necessary and again thoroughly rolled with the same roller to produce a smooth and even surface free from irregularities, true to line and level.

SECTION 27 - MARBLE

1. GENERAL

The work under this section of specifications consists of providing all material, labor, plant, equipment, appliances in any floor and at any height and performing all operations required for providing and installing marble natural stone slab for toilet counters, where shown on the drawings, complete in strict accordance with this section of the specification and the applicable Drawings.

2. SUBMITTALS

The Contractor shall submit manufacturer's specifications and other product data for each type of marble stone and fixtures required, including instructions for handling, storage, installation and protection.

Shop Drawings shall be submitted showing sires, dimensions, sections and profiles of slab, arrangement and provisions for jointing, anchoring, fastening and supports and other necessary fixing details. Indicate locations, layouts and pattern arrangements for each stone type and colour,

Submit three ranges samples 12" x 12" In size of each type of stone showing colour, grade, finishing and texture for approval of the Engineer

3. MATERIALS

3.1 GENERAL

Marble shall be compact, dense, meiam or poros rock of lime stone origin obtained from quarries within Pakistan. It shall have a specific gravity of 27 and hardness number on Moh's scale shall range from 3 to 4.

Obtain each marble stone type from a single quarry and ensure consistent color range and texture throughout the work. All pieces shall be of uniform thickness and truly square in shape.

Provide marble slabs/sills and tiles of specified sizes in floors, stair tread *&* rise •*$* and counter tops as shown on drawings.

Provide marble slabs/sills and tiles of type, colour and finish for each area as directed *by* the Engineer.

Provide stone of specified thickness. Saw cut the back surfaces that are meant to be concealed in finished work.

Provide irregular shaped unite, staircase unite and skirting base units to the profiles of required shapes S sizes and polished exposed surfaces wherever specified.

3.2 MARBLE STONE TYPE

All marble stone types are to be selected and approved by the Engineer for quality* colour and texture.

3.3 BEDS AND BACKINGS

Where applicable, standard cementious screed and mortar beds and backings, mixed and proportioned by volume shall be as follows. -

Grey ordinary Portland Cement:	1 part
Sand	2 parts
Water	Clean, fresh and free from deleterious substances

3.4 ADHESIVES, GROUTS AND SEALANTS

Proprietary adhesives, joint grouts and sealants of approved type as required and recommended by the manufacturer for specific application shelf *be* used. The colour of the joint grout and the sealants shall match with the colour of stone

4. DELIVERY, STORAGE AND HANDLING

Materials shall *be* protected from damage during loading, shipment, delivery and storage. Non-staining materials for blocking and packing shall be used Stack marble at site in accordance wrth manufacturer^ recommendations and as required to prevent staining, scratching, etching or breakage.

5. EXECUTION

5.1 FLOORING, SKIRTING/DADO AND STAIR

Apply cement slurry coat over surfaces of concrete substrate immediately prior to placing setting bed Limit area of application to avoid premature drying out. Install setting bed of required thickness and set stone units before initial set occurs. Apply a thin layer of cement paste to bottom of each unit. Set tamp and level units immediately set units in required pattern with uniform joint widths.

Point joints as soon as possible after initial set. force grout into joints, strike flush and tool slightly concave.

Remove mortar and grout from surfaces while stiff moist and as the work progresses.

Do not permit traffic on finished surface during setting and for a minimum of 24 hours after final pointing of joints.

5.2 REPAIR AND CLEANING

Remove and replace stone units, which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units, which do not match adjoining stonework or are not in line and level as shown on Drawings. Provide new matching units, install and point joints to eliminate evidence of replacement Re-point defective and unsatisfactory joints to provide neat, uniform appearance.

Clean stonework not less than 6 days after completion of work, using clean water and bristle brushes. Do not use wire brushes, acid or caustic type cleaning agents or other

cleaning compounds which may be detrimental to the stone finish or joint grout.

5.3 PROTECTION

Provide covers, boards, supports and all other necessary materials to protect finished work from collapse, deterioration, discoloration or damage during installation and until contract completion,

5.4 POLISHING

The finished surface shall be chemically polished, acceptable to the Engineer.

6. RELATED WORKS INCLUDED IN THE RELEVANT ITEMS OF BOQ.

The under mentioned works are related to the relevant BOQ items. The cost thereof shall *be* deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

- Class 'C' cement concrete screed base and cement sand mortar piaster base under marble floor and skirting/dado etc
- Finishing/grinding, washing *&* polishing works and all related items and marble tiles.
- 1:2 and 1.4 cement sand roughcast plaster.
- Pointing in marble tiles.

SECTION 28 - PORCELAIN TILES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Porcelain Tiles.

B. Related Sections include the following:

1. Division 3 Section "Cement Based Screeds" for floor screeds to receive ceramic tiles.

2. Division 5 Section "Architectural Joint Systems" for movement joints in ceramic flooring.

3. Division 7 Section "Cold Fluid-Applied Waterproofing" for waterproofing under thickset mortar beds.

4. Division 7 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

5. Division 9 Section "Portland Cement Plaster" for Portland cement scratch coat over metal lath on wall surfaces.

1.3 DEFINITIONS

A. **Module Size:** Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.

B. **Facial Dimension:** Actual tile size (minor facial dimension as measured per ASTM C 499).

C. **Facial Dimension:** Nominal tile size as defined in ANSI A137.1.

1.4 PERFORMANCE REQUIREMENTS

A. **Static Coefficient of Friction:** For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6.

B. **Load-Bearing** Performance: Provide installations rated for the following load-bearing performance level based on testing assemblies according to ASTM C 627 that are representative of those indicated for this Project:

1. Heavy: Passes cycles 1 through 12. Use where indicated in Finishing Schedules.
2. Moderate: Passes cycles 1 through 10. Use for other applications

indicated on Schedule where heavy duty is not indicated.

1.5 SUBMITTALS

A. **Product Data:** For each type of tile, mortar, grout, and other products specified.

B. **Shop Drawings:** For the following:

1. Tile patterns and locations.

2. Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

3. Locate precisely each joint and crack in tile substrates, record measurements on shop drawings, and coordinate them with tile joint locations, as approved by Consultant.

C. **Tile Samples for Initial Selection:** Manufacturer's color charts consisting of actual tiles or sections of tiles showing the full range of colors, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving color selection.

D. **Grout Samples for Initial Selection:** Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.

E. **Samples for Verification:** Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal color and texture variations, include Sample sets showing the full range of variations expected.

1. Each type and composition of tile and for each color and texture required, at least 400 mm square, mounted on braced cementitious backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Consultant.

2. Full-size units of each type of trim and accessory for each color required.

3. Stone thresholds in 150-mm lengths.

F. **Master Grade Certificates:** For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

G. **Product Certificates:** Signed by manufacturers certifying that the products furnished comply with requirements.

H. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.

I. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of Consultants and Employers, and other any information required by Consultant.

J. **Test Reports:** Material test reports from qualified independent testing

laboratory indicating and interpreting test results relative to compliance of tile and tile setting and grouting products with requirements indicated.

K. **Setting Material Test Reports:** Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

1.6 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Installer Qualifications:** Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. **Source Limitations for Tile:** Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.

D. **Source Limitations for Setting and Grouting Materials:** Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

E. **Source Limitations for Other Products:** Obtain each of the following products specified in this Section from one source and by a single manufacturer for each product:

1. Stone thresholds.

2. Cementitious backer units.

3. Joint sealants.

4. Waterproofing.

F. **Mockups:** Before installing tile, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed Work.

1. Locate mockups in the location and of the size indicated or, if not indicated, as directed by Consultant.

2. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain Consultant's approval of mockups before proceeding with final unit of Work.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   a. Approved mockups in an undisturbed condition as judged solely by

the Consultant at the time of Substantial Completion may become part of the completed Work, otherwise demolish mockups, remove rubbles from site and install permanent works.

G. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements of Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

C. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.8 PROJECT CONDITIONS

A. **Environmental Limitations:** Do not install tile until construction in spaces is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

1.9 EXTRA MATERIALS

A. Deliver extra materials to Employer. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS,

A. GENERAL

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.

2. Retain below with appropriate definitions in referenced part 1 article.

3. NA

4. Tiles are to be highest grade of production in manufacturer’s quality grading system.

B. **ANSI Standards for Tile Installation Materials:** Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.

C. **Colors, Textures, and Patterns:** Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or

materials complying with the following requirements:

1. Provide Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.

D. **Factory Blending:** For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.

E. **Mounting:** Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.

F. **Factory-Applied Temporary Protective Coating:** Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating them with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

A. **General Characteristics:** Tiles are to comply with the following general requirements:

1. Floor Tiles:

a. Abrasive Hardness: Minimum Index 253 to ASTM C 501 (unglazed tiles), unless otherwise specified.

b. Bending Strength: Minimum 35 Kg/cm^2 to ASTM C 648

c. Water Absorption: As specified.

d. Chemical Resistance: Unaffected with moderate acids.

e. Tile Rating: For heavy duty floor by a rating system acceptable to the Consultant.

2. Wall Tiles:

a. Water Absorption: Maximum 6% to ASTM C 373.

B. **Unglazed Paver Tile:** Provide flat tile complying With the following requirements:

1. Composition: Porcelain mix.

2. Constrition: Color-through.

3. Water Absorption: Less than 0.5% to ASTM C 373.

4. Surface Finish: Matt or Polished as indicated on Drawings.

5. Facial Dimensions: As indicated on Drawings.

6. Thickness: minimum 9.0 mm for tiles and 8.50 mm for fittings.

7. Face: Plain with Square or cushion edges.

C. **Wall Tile:** Provide flat tile complying with the following requirements:

1. Module Size: As indicated on Drawings.

2. Water Absorption: Less than 6% to ASTM C373.

3. Thickness: minimum 8.0 mm.

4. Face: Plain with modified square edges or cushion edges.

C. **Trim Units:** Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:

1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.

2. Shapes: As follows, selected from manufacturer's standard shapes:

a. Base for Portland Cement Mortar Installations: Coved.

b. Wainscot Cap for Thin-Set Mortar Installations: Surface bull nose.

c. External Corners for Thin-Set Mortar Installations: Surface bull nose.

d. Internal Corners: Field-butted square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

D. **Thickness of Tiles:** Specified thickness of tiles excludes thickness of keying patterns on back.

Background/Base: 15mm thick 1:4 cement/sand render on concrete or concrete block

works Bedding: Thin cement based adhesive to be approved

Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval.

Movement joints: All internal corners; Width: 6mrn

Accessories: all exposed edges and corners to have preformed rounded edges

2.3 PORCELAIN WALL TILING

Background/Base: 15mrn thick 1:4 cement/sand render on concrete or concrete blockworks.

Bedding: Thin bed cement based adhesive. Adhesive: to be approved

Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval.
Joint width: 3mm. Movement joints: Location: All internal corners; Width: 6mm

Accessories: all exposed edges and corners to have preformed rounded edges In toilets, no tiles behind low level ducts or full height ducts. Complete tiling should be done behind mirrors. In pantry, tiles are to be fixed behind base and wall units but not behind service duct panels. Plaster only where no tiles.

2.4 FLOOR TILING

Background/Base: screed 1 in-situ concrete

Screed: 11.5:3 cement/sand/aggregate semi-dry screed laid to falls and towards floor drain outlets, overall thickness of flooring to be 75mm Bedding: Waterproof adhesive on cement 1 sand bed Adhesive: to be approved

Waterproofing: 2 coats Fosroc Nitoproof 10, or equal, to B.S. Standard. laid to manufacturer's recommendations, with necessary accessories

Grouting material: Epoxy grout Nitotile 489 as supplied by Fosroc or equal approved to be used in accordance with manufacturer recommendations. Colour to architects approval

Joint width: 2.5mm.

Movement joints: location: At all perimeters including door thresholds; Width: 6mm-Accessories:

Skirting: Coved skirting tiles, 100mm high to match ceramic floor tiles, set flush with render, to be fixed on plastered walls, grouted with epoxy grout Nitotile 489 as supplied by Fosroc or equal approved, applied in accordance with manufacturer's recommendations.

2.5 NA

2.6 GROUTING MATERIALS

A. **Sand-Portland Cement Grout:** ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.

B. **Chemical-Resistant Epoxy Grout:** ANSI A 118.3, color as indicated.

1. Provide product capable of resisting continuous and intermittent exposure to temperatures of up to 60 deg C and 100 deg C, respectively, as certified by mortar manufacturer for intended use.

C. **Grout Colors:** Provide colors as selected by the Consultant from manufacturer’s full range of standard and custom colors. Finish shall be smooth, unless otherwise specified or directed by the Consultant.

2.7 ELASTOMERIC SEALANTS

A. **General:** Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements of Division 7 Section "Joint Sealants."

B. **Colors:** Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

2.8 MISCELLANEOUS MATERIALS

A. **Trowelable Underlayments and Patching Compounds:** Latex-modified, Portland-cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. **Temporary Protective Coating:** Provide product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; is compatible with tile, mortar, and grout products; and is easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 49 to 60 deg C per ASTM D 87.

C. **Tile Cleaner:** A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.9 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.

SECTION 29 - TERRAZZO TILE AND CAST IN SITU TERRAZZO

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Terrazzo Tiles Flooring.

2. Cast in Situ Terrazzo.

B. Related Sections include the following:

1. Division 3 Section "Cement Based Screeds" for floor screeds to receive ceramic tiles.

2. Division 5 Section "Architectural Joint Systems" for movement joints in ceramic flooring.

3. Division 7 Section "Cold Fluid-Applied Waterproofing" for waterproofing under thickset mortar beds.

4. Division 7 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

5. Division 9 Section "Portland Cement Plaster" for Portland cement scratch coat over metal lath on wall surfaces.

1.3 DEFINITIONS

A. **Module Size:** Actual tile size (12” x 12” x 1”thick).

B. **Facial Dimension:** Actual tile size (minor facial dimension as measured per ASTM C 499).

C. **Facial Dimension:** Nominal tile size as defined in ANSI A137.1.

1.4 PERFORMANCE REQUIREMENTS

A. **Static Coefficient of Friction:** For tile installed on Flooring surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1 Level Surfaces: Minimum 0.6.

B. **Load-Bearing Performance:** Provide installations rated for the following load bearing performance level based on testing assemblies according to ASTM C 627 that are representative of those indicated for this Project:

1. Heavy: Passes cycles 1 through 12. Use where indicated in Finishing Schedules.

2. Moderate: Passes cycles 1 through 10. Use for other applications indicated on Schedule where heavy duty is not indicated.

1.5 SUBMITTALS

A. **Product Data:** For each type of tile, mortar, grout, and other products specified.

B. **Shop Drawings:** For the following:

1. Tile patterns and locations.

2. Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

3. Locate precisely each joint and crack in tile substrates, record measurements on shop drawings, and coordinate them with tile joint locations, as approved by Consultant.

C. **Tile Samples for Initial Selection:** Manufacturer's color charts consisting of actual tiles or sections of tiles showing the full range of colors, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving color selection.

D. **Grout Samples for Initial Selection:** Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.

E. **Samples for Verification:** Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal color and texture variations, include Sample sets showing the full range of variations expected.

1. Each type and composition of tile and for each color and texture required, at least 12” x 12” mm square, mounted on braced cementitious backer units, and with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by Consultant.

2. Full-size units of each type of trim and accessory for each color required.

F. **Master Grade Certificates:** For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

G. **Product Certificates:** Signed by manufacturers certifying that the products furnished comply with requirements.

H. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product.

I. **Installer Experience:** List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of Consultants and Employers, and other any information required by Consultant.

J. **Test Reports:** Material test reports from qualified independent testing laboratory

indicating and interpreting test results relative to compliance of tile and tile setting and grouting products with requirements indicated**.**

K. **Setting Material Test Reports:** Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

1.6 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Installer Qualifications:** Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. **Source Limitations for Tile:** Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.

D. **Source Limitations for Setting and Grouting Materials:** Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

E. **Source Limitations for Other Products:** Obtain each of the following products specified in this Section from one source and by a single manufacturer for each product:

1. Stone thresholds.

2. Cementitious backer units.

3. Joint sealants.

4. Waterproofing.

F. **Mockups:** Before installing tile, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed Work.

1. Locate mockups in the location and of the size indicated or, if not indicated, as directed by Consultant.

2. Notify Consultant 7 days in advance of the dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain Consultant's approval of mockups before proceeding with final unit of Work.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   a. Approved mockups in an undisturbed condition as judged solely by the Consultant at the time of Substantial Completion may become part of the completed Work, otherwise demolish mockups, remove rubbles

from site and install permanent works.

G. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements of Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

C. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

1.9 EXTRA MATERIALS

A. Deliver extra materials to Employer. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1 Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.

2. Retain below with appropriate definitions in referenced part 1 article.

3. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.

4. Tiles are to be highest grade of production in manufacturer’s quality grading system.

B. **ANSI Standards for Tile Installation Materials:** Provide materials complying with ANSI standards referenced in "Setting Materials" and "Grouting Materials" articles.

C. **Colors, Textures, and Patterns:** Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface

textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

1 . Provide Consultant's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.

D. **Factory Blending:** For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.

E. **Mounting:** Where factory-mounted tile is required, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless another mounting method is indicated.

F. **Factory-Applied Temporary Protective Coating:** Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating them with a continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

A. **General Characteristics:** Tiles are to comply with the following general requirements:

1. Floor Tiles:

a. Abrasive Hardness: Minimum Index 253 to ASTM C 501, unless otherwise specified.

b. Bending Strength: Minimum 35 Kg/cm^2 to ASTM C 648

c. Water Absorption: As specified.

d. Chemical Resistance: Unaffected with moderate acids.

e. Tile Rating: For heavy duty floor by a rating system acceptable to the Consultant.

f. Water Absorption: Maximum 6% to ASTM C 373.

3.1 TERRAZZO TILE

The ingredients of the terrazzo topping finish of the tiles shall confirm the Specification stipulated for in situ Terrazzo finish herein above. The tiles shall be made by mechanical compression process and shall be of first grads. The size shall be 12” x 12” x 1” thick for floor and ½” thick for skirting. The tile shall be composed of one part of cement and two parts of marble chips. The compositions given above applies to 10 mm thickness of the top surface of the tile remaining portion being composed of normal 1:2 cement and course sand mortar. The size and colour composition of the marble chips shall be according to Consultant’s instruction. Tiles shall be well shaped perfectly square with straight edges perfectly flat and free from defect which may defect its appearance of serviceability. Tiles with chips or cricks when being installed will not be acceptable. The following samples should be submitted to the Consultant.

Terrazzo tile 2 of each type

Coloring	0.25 kg of each type
Cleaning Compound	1 can of each.

The plain concrete sub-floor surfaces to receive the setting bed for tiles shall be clean and free of dirt, dust, oil or other objectionable matter. Setting beds for terrazzo tile flooring shall be composed of 1 part cement and 2 parts sand by volume with minimum amount of water necessary to produce a workable mass and shall be laid to an average thickness of 25 mm. This shall be covered with neat cement grout of creamy consistency. As large as area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be less then mm. tiles shall be laid out from the center line of each space outward and in straight lines in a symmetrical pattern with a minimum of cut tiles. Joints between tiles shall be as uniform width. Tile shall be cut with a suitable tool and rough edges shall be rubbed smooth Tile shall be laid to the straight edges.

Floor should be kept wet for 3 days no one should be allowed to walk on tiles during that period.

After seven days of laying the tiles the terrazzo tile floors shall be machine ground to a true even surface using various grades of abrasive stones as required. After the first grinding the floor shall be thoroughly grouted with the same cement and colour composition as used for the manufacture of tiles top surface. The grout shall be of the consistency of thick cream and shall be brushed over the floor to eliminate all blemishes and to thoroughly fill the surface for final grinding. Not less than 72 hours after application, the grouting coat shall be removed by grinding. The final surface should have very smooth finish. Small areas, inaccessible portions and corners which cannot be reached by the grinding machine shall be ground and rubbed by hand. The final gloss should be given polishing the surface to the satisfaction of the consultant.

3.2 TERRAZZO SKIRTING TILES

The terrazzo skirting tiles shall be the same as or terrazzo floor tiles except that the skirting tiles shall be 4" x 12" and shall be laid over ½" rough plaster and shall be manufactured and finished in the same manner as the floor tiles.

4.0 FLOOR TILE MEASUREMENT & PAYMENT

Measurement for terrazzo tile shall be made of the net Sq. Ft area on which the terrazzo tile are laid and only approved by the Consultant.

The laid prices tendered for this work shall include the cost of the tiles and all other materials, supplying, mixing and applying, setting bed and slurry, grinding and finishing and of all plant, operation, procedures and requirements necessary of finish this work in accordance with these specification.

4.1 Measurement of terrazzo tile skirting shall be made at the net Rft. Length on which the skirting is laid and duty approved by the Consultant.

the Unit Prices tendered for this work shall include the cost of tiles and all other materials, supplying, mixing and applying, setting plaster and slurry curing, grinding and finishing and of all plants, operations, procedures and requirements necessary to finish this work in accordance with these Specifications.

5.0 CONSTRUCTION REQUIREMENTS IN SITU TERRAZZO FLOORING

The floor shall consist of a wearing surface of consistency and net thickness as specified in Bill of Quantities, laid over 1:2:4 concrete base of the specified thickness. The net thickness specified for wearing surface shall be that obtained after grinding and polishing, 1:2:4 concrete shall be mixed and laid in the manner specified for cement concrete floor, using a minimum quantity of water for workability.

The cement concrete shall be leveled with a trowel and straight edge, consolidated and finished with steel trowels to an even but rough surface. The top layer of cement marble chips mixed in the proportion of 1:2 (1 cement and 2 marble Chips) shall be laid over it within 24 hours. The cement and marble chips must be mixed dry in such quantities as are sufficient for a unit of one specified shade. Water shall be added to only such quantities as can be mixed thoroughly and consumed in less than 30 minutes, the quantity of water being the minimum for workability. Mixing must be done on water tight platform and any mix not used within 30 minutes shall be discarded and removed from site. A layer of cement and marble chipping mixture should be well trowelled into the surface of the base concrete before filling to the top level of the screeds. The layer should be well compacted and all voids shall be filled in. A layer of neat cement, of the specified colour shall then be well trowelled into the surface leaving a plain smooth surface.

Floors shall be laid in panels of about 4.0'x4'-Q (1.2 x 1.2 meter) or of size as shown on the drawings. Dividing strips of aluminum/brass/glass as specified shall be provided and fixed to exact levels making an allowance for grinding. Aluminum strips shall not be less than 3mm thick and of width equal to the total thickness of cement concrete base and Terrazzo Topping.

Three days after laying the top layer must be evenly and smoothly machine ground with carborandum blocks of coarse, medium and fine grades so as to ensure that all marble chippings are evenly exposed allover the surface. If marble chips are not evenly exposed the Contractor shall pull down the surface and relay it at his own cost. After the first grinding, the floor shall be thoroughly grouted with the same cement and colour composition as specified for the terrazzo mix. The grout shall be of the consistency of thick cream and shall be brushed over the floor to eliminate all impressions and thoroughly fill the surface for final grinding. The surface after grinding shall be left un-disturbed and cured for 2 or 3 weeks, after which it shall be cleaned of dirt and dust by rubbing gently with pumice stone or washing soda in sufficient water. Three days after the surface has been cleaned it shall be rubbed hard with 1:10 solution of oxalic acid using felt. The surface shall then be cleaned and washed with plenty of water. After the surface has dried a final gloss shall be given by polishing the surface. The walls and all surfaces of the finished works of other trades shall be properly protected from damage and spoiling during the process of grinding and washing of the terrazzo. After the finish grinding has been completed and the surface treatment applied, the terrazzo work shall be covered and protected with approved material until completion of the work of all other trades.

TERRAZZO TILE FLOORING AND CAST IN SITU TERRAZZO

6.0 TERRAZZO DADO AND SKIRTING

The marble chips and cement shall conform to specification for floor. Mixing shall be done in the same manner and proportion. The plastered surface over which the dado/skirting is 'to be applied shall be well roughened and watered; cement mortar of specified ratio shall then be plastered over this well roughened surface to indicated thickness. Before the base course has set the layer of terrazzo mixture shall be well trowelled into the surface of the base to a thickness which after grinding shall result in the finished thickness as per Bill of Quantities. A layer of neat cement of the specified colour shall then be well trowelled into the surface leaving a plain smooth surface. After the period specified for floors above, the Contractor shall start finishing as for

floors specified above. Terrazzo skirting shall be provided around all terrazzo floors unless shown otherwise. Skirting and dado shall be straight, level and in plumb. Intersections at floors shall be straight and flush.

7.0 TERRAZZO ON STAIRS

The stair risers and treads shall be finished according to exact sizes including the terrazzo topping making allowance for grinding of terrazzo. The nosing shall be flush with the terrazzo toppings, and shall be protected by aluminum angles as specified or shown on Drawings. The angles shall be firmly secured, by means of counter-sunk brass screws and cast together with the step.

8.0 MEASUREMENT

Work for floor and dado shall be measured in Sq.Ft. /M of wall and floor area, skirting shall be measured in Lin.Ft./H.

8.1 RATE AND PAYMENT

The rate for all items of work under this section shall cover the cost of furnishing all materials, labour, scaffolding framework laying, curing, grinding, polishing, finishing and appliances at site and performing all operations at any height in accordance with drawings, Bill of Quantities and as specified. The rate shall include the cost of furnishing and installing metal fixings, dividing strips for floors, dados, nosing, angles aluminum U-channels and screws for stairs etc., and providing all assistance to other trades for built in items etc.

SECTION 30 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes surface preparation and field painting of the following:

1. Exposed exterior items and surfaces.

2. Exposed interior items and surfaces.

3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Consultant will select from standard colors and finishes available.

C. Do not paint pre-finished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

2. Operating parts include moving parts of operating equipment and the following:

3. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.

2. Division 8 Section "Flush Wood Doors" for shop priming wood doors.

3. Divisions 15 and 16: Painting of mechanical and electrical work is specified in Divisions 15 and 16, respectively.

1.3 DEFINITIONS

A. **General:** the following coating terms apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.

2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.

3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when

measured at a 60-degree meter.

4. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.

5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. **Product Data:** For each paint system specified. Include block fillers and primers.

1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.

B. **Samples for Initial Selection:** Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1. After color selection, the Consultant will furnish color chips for surfaces to be coated.

C. **Samples for Verification:** Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.

2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.

3. Submit Samples on the following substrates for the Consultant's review of color and texture only:

a. Concrete: Provide two 100-mm- square samples for each color and finish.

b. Ferrous Metal: Provide two 100-mm- square samples of flat metal and two 200-mm- long samples of solid metal for each color and finish.

D. **Qualification Data:** For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Consultants and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. **Quality System:** Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Consultant and the Employer.

B. **Applicator Qualifications:** Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

C. **Source Limitations:** Obtain fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

D. **Benchmark Samples (Mockups):** Provide a full-coat benchmark finish sample of each type of coating and substrate required on the Project.

1. The Consultant will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.

    a. Wall Surfaces: Provide samples on at least 9 sq. m of wall surface.

    b. Small Areas and Items: The Consultant will designate an item or area as required.

2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface according to the Schedule or as specified. Provide required sheen, color, and texture on each surface.

    a. After finishes are accepted, the Consultant will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from job-applied samples.

E. **Manufacturers Qualifications:** Paint materials shall be the products of paint and coating manufacturers whose qualifications are as follows:

1. Manufacturers shall be reputable of multi-national scale in production and distribution with capabilities to deliver paint materials quantities necessary for the project on due time.

2. Manufacturers shall have evidence from scientific bodies that demonstrate their participation and share in the development of paint industry generally and production of new painting materials kinds.

3. Manufacturers shall have their own proprietary brand names that are well known worldwide.

4. Manufacturers shall have minimum 25 years of successful experience in producing painting materials for use in prestigious projects worldwide of same standard of quality as that intended for the Project.

5. Manufacturers shall be registered in the associations, councils, boards, federations or other similar bodies of paint manufacturers in countries of origin and practice.

F. **Performance of Paints:** Paints shall be fit for purpose and manufactured specifically for the applications indicated and uses intended, taking into account the type, nature, location, and aesthetic and utility requirements of the Project.

1. Opacity: Paint shall cover or hide the substrate to the Consultant's satisfaction.

2. Cleanability: Paint shall not absorb dirt and shall be capable of being washed or scrubbed periodically, to the Consultant's satisfaction, without adverse effect on its attributes or appearance.

3. Scrub resistance wet and dry: paint shall resist abrasion caused by scrubbing in accordance with ASTM D 2486.

4. Adhesion: Paint shall adhere firmly to the substrate without peeling.

5. Exposure resistance: Paint shall resist yellowing and weathering caused by UV rays and ozone.

G. **Standards:** Paints shall be manufactured to relevant US standards, or any other international standard approved by Authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:

1. Product name or title of material.

2. Product description (generic classification or binder type).

3. Manufacturer's stock number and date of manufacture.

4. Contents by volume, for pigment and vehicle constituents.

5. Thinning instructions.

6. Application instructions.

7. Color name and number.

8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7 deg C. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 10 and 32 deg C.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 7.2 and 35 deg C.

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 3 deg C above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to the Employer.

1. Quantity: Furnish the Employer with an additional 5 percent, but not less than 3.8L or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 PAINT MATERIALS, GENERAL

A. **General:** Employed paints and painting materials shall be the highest grade and top quality in manufacturer's range of products for the generic kind of paint or paint material.

B. **General:** Materials for paint works shall comply with requirements of BS 6150, as applicable.

C. **Material Compatibility:** Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

D. **Material Quality:** Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

E. **Colors:** Provide color selections made by the Consultant or by reference to manufacturer's color designations.

2.2 ANTI-CARBONATION PAINT MATERIALS, GENERAL

A. Paint for application on internal and external is to be anti-carbonation paint that is easy to clean, applicable on new or existing concrete, Portland cement plaster or masonry, water-based and non toxic, allows substrate to breath, Protects substrates form Carbonation, of elastic nature with crack bridging properties.

B. Anti-carbonation paint is to be self-cleaning by application of just sprayed water, highly durable, copolymer based coating which cures to form a tightly adherent, decorative weatherproof membrane guaranteed for up to 15 years. The formed coating membrane shall tolerate thermal movement in the substrate without splitting or cracking and will retain its elastomeric properties even after prolonged exposure to ultra-violet light. Coating shall have the advantage of being reinforced using glass fiber matting or tapes and shall be capable of bridging cracks or joints between different substrates. The finished surface shall be chemical and pollution-resistant surface that has been specially manufactured to shed dirt, ensuring that it retains a bright, attractive appearance throughout its life. Coating shall be vapor permeable and allows entrapped substrate moisture to escape without causing blistering or delamination and shall produce an effective barrier to carbon dioxide diffusion and provide reinforced concrete substrates with an excellent defense against the harmful effects of carbonation. Color and sheen shall be selected by the Consultant from manufacturer’s full range of products.

C. Anti carbonation paint shall also comply with following properties;

1. Carbon Dioxide Diffusion Resistance, Taywood Method

   a. Equivalent Thickness of Air: More than 175 mm.

   b. Equivalent Thickness of 30N Concrete: More than 500 mm;

2. Chloride Ion Diffusion Coefficient: No chloride ion diffusion after 60 days; Taywood Method

3. Static Crack Spanning Capability for 200-micron Dry Film Thickness at 23 ºC: Minimum 2.00 mm to ASTM C836.

4. Tear Resistance: 15 N/mm to ASTM D1004.

5. Tensile Strength: 5.00 N/mm2 to ASTM D412.

6. Reduction in Water absorption: Not less than 82% to ASTM C642.

7. Reduction in Chloride Ions Penetration: Not less than 92% to AASHTO M259.

8. Adhesion: Not less than 1.00 N/mm2, BS 1881.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.

1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. **Coordination of Work:** Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Consultant about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

A. **General:** Preparation of surfaces to receive paints is to be according with requirements of BS 6150 and recommendations of paints manufacturer.

B. **General:** Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

C. **Cleaning:** Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

D. **Surface Preparation:** Clean and prepare surfaces to be painted according to

manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.

2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

    a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.

    b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.

    c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.

3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreignsubstances. Use solvent or mechanical cleaning methods that comply with recommendations of referenced standards.

    a. Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of referenced standards.

    b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

    c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.

4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

E. **Materials Preparation:** Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

3. Use only thinners approved by paint manufacturer and only within recommended limits.

F. **Tinting:** Tint each undercoat a lighter shade to simplify identification of each coat

when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. **General:** Apply paint according to recommendations of BS 6150 and manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in the schedules.

2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

3. Provide finish coats that are compatible with primers used.

4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.

5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.

7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.

9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.

10. Sand lightly between each succeeding enamel or varnish coat.

B. **Scheduling Painting:** Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

2. Omit primer on metal surfaces that have been shop primed and touchup painted.

3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. **Application Procedures:** Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. **Minimum Coating Thickness:** Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. **Mechanical and Electrical Work:** Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. **Prime Coats:** Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

G. **Pigmented (Opaque) Finishes:** Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

H. **Transparent (Clear) Finishes:** Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.

1. Provide satin finish for final coats.

I. **Stipple Enamel Finish:** Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

J. **Completed Work:** Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 FIELD QUALITY CONTROL

A. The Employer reserves the right to invoke the following test procedure at any time and as often as the Employer deems necessary during the period when paint is being applied:

1. The Employer will engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in the presence of the Contractor.

2. The testing agency will perform appropriate tests for the following characteristics as required by the Employer:

    a. Quantitative material analysis.

    b. Abrasion resistance.

    c. Apparent reflectivity.

    d. Flexibility.

    e. Washability.

    f. Absorption.

    g. Accelerated weathering.

    h. Dry opacity.

    i. Accelerated yellowness.

    j. Recoating.

    k. Skinning.

    l. Color retention.

    m. Alkali and mildew resistance.

3. The Employer may direct the Contractor to stop painting if test results show material being used does not comply with specified requirements. The Contractor shall remove noncomplying paint from the site, pay for testing, and repaint surfaces previously coated with the rejected paint. If necessary, the Contractor may be required to remove rejected paint from previously painted surfaces if, on repainting with specified paint, the 2 coatings are incompatible.

3.5 CLEANING

A. **Cleanup:** At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.6 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Consultant.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

3.7 EXTERIOR PAINT SCHEDULE

A. Coordinate the following paint coats with surface preparation steps as specified.

B. B. Concrete and Cement Sand Portland Plaster: Provide the following finish system over exterior concrete and Portland Cement Plaster.

1. Light Textured Emulsion Paint

    a. 100% pure acrylic-based paint specially formulated for external

application. The paint is to dry by evaporation of water and will produce a durable, flexible, excellent water and alkali resistant and is to provide long lasting protection for coated surfaces. The paint is to be UV-resistant, of high bond strength to substrates and distinguished color retention, and is to provide anti-carbonation shield for the substrate while allowing moisture of substrate to escape to the outside.

b. Finished surface is to be of light texture.

C. **Ferrous Metal:** Provide the following finish system over exterior ferrous metal.

1. Full-Gloss, Epoxy-Based Enamel: Two finish coat over primer.

a. Primer: High-molecular-weight, epoxy-resin primer at spreading rate recommended by manufacturer.

b. Finish Coat: High-molecular-weight, epoxy-resin topcoat at spreading rate recommended by the manufacturer.

c. Protection Coating: Two Coats of clear polyurethane-based, UV resistant protection coating.

3.8 INTERIOR PAINT SCHEDULE

A. Coordinate the following paint coats with surface preparation steps as specified.

B. Concrete: Provide the following paint systems over interior concrete and masonry surfaces

1. Flat Acrylic Finish: 2 finish coats over a primer.

a. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.025 mm.

2. First and Second Coats: Flat, acrylic latex-based, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.060 mm per coat.

C. **Plaster:** Provide the following finish systems over new, interior Portland cement plaster surfaces:

1. Flat Acrylic Finish: 2 finish coats over a primer.

a. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.036 mm.

b. Undercoat: same material for finish coats specified hereafter diluted to the manufacturer's recommendations.

c. First and Second Finish Coats: Flat, acrylic-latex, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.064 mm per coat.

2. Semigloss, Alkyd-Enamel Finish: One finish coat over an undercoat and a primer.

a. Primer: Alkali-resistant, alkyd- or latex-based, interior primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).

b. First and Second Coats: Semigloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.066 mm.

D. **Woodwork and Hardboard:** Provide the following paint finish systems over new, interior wood surfaces:

1. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a wood undercoater.

a. Undercoat: Alkyd- or acrylic-latex-based, interior wood undercoater, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.066 mm.

2. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a wood undercoater.

a. Undercoat: Alkyd, interior enamel undercoater applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

b. First and Second Coats: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.061 mm.

E. **Stained Woodwork:** Provide the following stained finishes over new, interior woodwork:

1. Alkyd-Based, Satin-Varnish Finish: 2 finish coats of an alkyd-based, clear-satin varnish over a sealer coat and an alkyd-based, interior wood stain. Wipe wood filler before applying stain.

a. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

b. Stain Coat: Alkyd-based, interior wood stain applied at spreading rate recommended by the manufacturer.

c. Sealer Coat:Clear sanding sealer applied at spreading rate recommended by the manufacturer.

d. First and Second Finish Coats: Alkyd-based or polyurethane varnish, as recommended by the manufacturer, applied at spreading rate recommended by the manufacturer.

F. **Zinc-Coated Metal:** Provide the following finish systems over zinc-coated metal:

1. Full-Gloss, Alkyd-Enamel Finish: One finish coat over an enamel undercoat and a primer.

a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

b. Undercoat: Alkyd, interior enamel undercoat or semigloss, interior, alkyd-enamel finish coat, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

c. Finish Coat: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

G. **Ferrous Metal:** Provide the following finish systems over ferrous metal:

1. Full-Gloss, Alkyd-Enamel Finish: two finish coat over a primer.

a. Primer: Interior ferrous-metal primer at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm.

b. Finish Coat: Full-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 0.031 mm percoat.

H. **Ferrous Metal:** Provide the following finish systems over ferrous metal:

1. Full-Gloss, Epoxy-Based Enamel: Two finish coat over primer.

a. Primer: High-molcular-weight, epoxy-resin primer at spreading rate recommended by manufacturer.

b. Finish Coat: High-molcular-weight, epoxy-resin topcoat at spreading rate recommended by the manufacturer.

SECTION 31 – TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Related Drawing and Detail.

1.2 SUMMARY

A. This Section includes the following:

1. Toilet and bath accessories.
2. Warm-air dryers.

B. Related Sections include the following:

1. Division 8 Section "Mirrored Glass" for mirrors.
2. Division 9 Section "Ceramic Tile" for ceramic toilet and bath accessories.
3. Division 16 Sections for the characteristics of electrical power in the project for hand dryers.

1.3 SUBMITTALS

A. **Product Data:** Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.

B. **Samples:** For each accessory item to verify design, operation, and finish requirements.

1. Approved full-size Samples will be returned and may be used in the Work.

C. **Setting Drawings:** For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.

D. **Product Schedule:** Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use designations indicated in the Toilet and Bath Accessory Schedule and room designations indicated on Drawings in product schedule.

E. **Maintenance Data:** For accessories to include in maintenance manuals specified in Division 1. Provide lists of replacement parts and service recommendations.

1.4 QUALITY ASSURANCE

A. **Product Options:** Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule.

1. Products of other manufacturers listed in Part 2 with equal characteristics, as judged solely by Consultant, may be provided.

2. Other manufacturers' products with equal characteristics may be considered. See Division 1 Section "Substitutions."

3. Do not modify aesthetic effects, as judged solely by Consultant, except with Consultant's approval. Where modifications are proposed, submit comprehensive explanatory data to Consultant for review.

1.5 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.

F. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.6 WARRANTY

A. **General Warranty:** Special warranty specified in this Article shall not deprive Employer of other rights Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. **Manufacturer's Mirror Warranty:** Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.

1. Minimum Warranty Period: 15 years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.8-mm minimum nominal thickness, unless otherwise indicated.

B. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16M, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.

C. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.9-mm minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.

D. Galvanized Steel Sheet: ASTM A 653/A 653M, Z180.

E. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal**.**

F. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.

G. Mirror Glass: as per requirements of Division 8, section “Mirrored Glass”.

H. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

I. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed**.**

2.2 FABRICATION

A. **General:** Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

B. **Surface-Mounted Toilet Accessories:** Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.

C. **Recessed Toilet Accessories:** Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.

D. **Mirror-Unit Hangers:** Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:

1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.

2. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

E. **Keys:** Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Employer's representative.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.

3.2 ADJUSTING AND CLEANING

A. Remove temporary labels and protective coatings.

B. Clean and polish exposed surfaces according to manufacturer's written recommendations.

3.3 TOILET AND BATH ACCESSORY SCHEDULE

A. **Toilet Tissue Dispenser (Toilet Paper Holder):** Provide toilet tissue dispenser complying with the following:

1. Type Single-roll dispenser.

2. Mounting: Surface mounted with concealed anchorage.

3. Material: Stainless steel

4. Operation: Non-control delivery with mfr's standard spindle.

5. Capacity: Designed for standard diameter-core tissue rolls up to 140 mm diameter (800 sheets)

B. **Soap Dish:** Stainless steel size and shape as selected by the Consultant from manufacturer's standard range.

C. **Soap Dispenser:** Provide soap dispensers complying with the following:

1. Liquid Soap Dispenser, Vertical-Tank Type: Wall mounted type, minimum 1182.9 ml capacity tank with stainless steel piston, springs, and internal parts designed to dispenses soap in measured quantity by pump action, and stainless-steel cover with unbreakable window-type refill indicator.

a. Mounting: Designed for wall mounting.

b. Soap Valve: Designed for dispensing soap in liquid form.

D. **Paper Towel Dispenser:** 800 multi-hold towels capacity, stainless steel, surface mounted.

E. Robe Hook

1. Stainless steel.

2. Double-prong with rectangular wall bracket and back plate for concealed mounting.

F. Grab Bar

1. Surface mounting, exposed.

2. Stainless steel.

3. 38 mm outside diameter and 1.20 mm minimum wall thickness and 38 mm distance from inside of bar and face of wall.

4. Furnish complete with two end flanges, 3 mm thick minimum and 76 mm diameter, each of three countersunk screw holes for attachment to walls.

5. Use of flanges with snap covers is acceptable.

G. **Warm-Air Dryer:** Provide warm-air dryer complying with the following:

1. Touch-Button-Activated Hand Dryer: Surface-mounted, warm-air hand dryer activated by touch button and with manufacturers' standard, white-painted metal cover and 30-second-timed power cut-off switch.
