INTERNATIONAL ORGANIZATION FOR MIGRATION

Modification and Repurposing of Existing Hotel Structure for IOM MHAC and TC

STANDARD TECHNICAL SPECFICATION

JULY 2023

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ETHIOPIAN CONSTRUCTION PRACTICE NORMS
COMPULSORY STANDARD: CS-167

STANDARD TECHNICAL SPECIFICATION FOR BUILDING WORKS

MINISTRY OF CONSTRUCTION

NATIONAL FOREWORD

The Proclamation to define the powers and duties of The Executive organs of The Federal Democratic Republic of Ethiopia Proclamation No. 916/ 2015 empowers the Ministry of Construction to prepare the Country's Building Code, issue Standards for design and construction works, and follow up and supervise the implementation of same.

The purpose of these standards is serving as nationally recognized documents, the application of which is deemed to ensure compliance of buildings with the minimum requirements for design, construction and quality of materials set down by the Building Proclamation.

The major benefits to be gained in applying these standards are the harmonization of professional practices and the ensuring of appropriate level of workmanship and quality of construction works.

This standard is the first of its kind that demand the full application of requirements defined by various standards published by Ethiopian Standard Agency (ESA). Moreover it will serve as a tool for strict compliance with provisions of various proclamations and regulations that are applicable to the construction industry. It is also a basis for preparing a nonrestrictive project specification that is required by the public procurement directive issued by the Ministry of Finance and Economic Development, in 2010.

This Standard Technical Specification is a national resource tool and reference document, containing more than 60 specification sections, to be used for uniform preparation of specifications in all government building projects. Specifications of all public building projects shall, therefore, be developed based on requirements of this standard with a consistent logic, appearance and style as of the publication date of this standard. Professionals involved in the preparation of project specifications shall be well trained and knowledgeable on the fundamental principles of specification writing and on the application of requirements stipulated in this technical specification to specific building projects.

This Standard Specification, having provisions related to all building works, was first published in 1991 and revised in 1995. This newly revised edition has been brought out to incorporate the

Building Proclamation and the changes found necessary in the light of usage of this standard and suggestions provided by various implementing bodies.

As this standard is a technical document which, by its very nature, require periodic updating, it will also be revised and reissued by the Ministry from time to time when it is found appropriate.

Ambachew Mekonnen (PhD)
Minister, Ministry of Construction,
Federal Democratic Republic of Ethiopia

PREFACE

This Standard Technical Specification is prepared by HABCON CONSULT based on the requirements of the standard for a classification framework (ISO 12006-2), which is developed by the International Organization for Standardization (ISO) and the International Construction Information Society (ICIS).

This standard is organized in four Groups that comprise 17 divisions. Each division has Six digit numbering system that are defined and designated for a definite purpose. The language used in the technical specification is carefully articulated to be Complete, Correct, and Concise & Clear.

The style of writing is presented based on the PageFormat standard that provide a concise and orderly arrangement of Articles, Paragraphs and Subparagraphs and addresses the physical arrangement on the page, such as margins, indents, headers and footers.

The specification sections are organized based on requirements of the SectionFormat standard, which provides a uniform approach to organizing specification text through establishing a structure consisting of three primary PARTS namely GENERAL, PRODUCTS & EXECUTION. The content and level of coverage for each section is prepared to sufficiently address the current demand in the construction industry.

This Standard Technical Specification is developed as a guide for preparing nonrestrictive building project specification through application of available standards primarily from ES, EBSC, BS and BS-EN.

HABCON CONSULT would like to acknowledge Ato Hagos Abdie, Ato Yaregal Ali and Ato Melese Haile for their unreserved effort in the Preparation of this Standard.

HAGOS ABDIE
GENERAL MANAGER
HABCON CONSULT

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DIVISION 01 – GENERAL REQUIREMENTS

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SECTION 011000

SUMMARY

PART 1 GENERAL

1.01 APPLICABILITY OF DIVISION 01 'GENERAL REQUIREMENTS'

A. All Sections incorporated under DIVISION - 1 (GENERAL REQUIREMENTS) in this Specifications, covers items that are applicable to all parts of the Sections in this Specifications. Therefore, all the Specifications under DIVISION - 1 (GENERAL REQUIREMENTS) in this Specifications, whether stated or implied shall be considered equally applicable to all Sections in this Specifications.

B. Project specifications shall be coordinated to avoid conflicting requirements between each Sections of Division 01 and the Sections of all Divisions of the specifications, and among the Sections of Division 01 that cover interrelated administrative and Procedural requirements.

C. The Contractor shall request the Engineer clarification for any conflicting requirements in the Contract Documents and the Engineer shall decide the governing requirement before commencing execution of the Work.

1.02 SUMMARY OF THE WORK

A. Work covered by Contract Documents:
   1. Site description:
      a. Title and location: The title and location of the Work shall be printed on the cover of Contract Documents.
      b. The site description of the Work shall indicate the following in detail as required:
         1) Region, particular name and geographic location.
         2) Elevation of area.
         3) Access Road - specify distance of tarmac, gravel and dust road and no access distances. (If in the opinion of the Specifier, the project is located in an area known to all prospective Contractors, only the required details shall be given).
         4) Availability of services such as water, power, telephone, etc.
            a) If data is available, the climatic data indicating the following:
            b) Seasons of rain, indicating the heaviest month of rain.
            c) Seasons of lowest and highest temperature - months of high and low humidity.
            d) Prevailing wind and months of high wind velocity.
            e) Records of monthly rainfall, wind speed and humidity.

      c. A location map of the area shall be attached wherever possible.
      d. Possible sources of naturally occurring materials like stone for masonry, aggregate, sand, etc., shall be indicated.

   2. Type of Contract: The type of contract shall be indicated in the Contract Documents.

3. Cost included: Cost of materials (as indicated on drawings or specified in the Specification, Bill of Quantities, Schedules, etc.), labor, equipment, tools, temporary works, supervisory personnel and related items required for the satisfactory execution of an item shall he deemed as included in the cost whether such requirement is specifically stated or not.

B. Work covered by Procuring Entity:
   1. The Works covered by the Procuring Entity are stated in the Contract Documents.
      a. The Contractor shall inform to the Engineer for the any unclear and ambiguities for Work covered by the Procuring Entity before proceeding to any related Contract Works.

C. Items not Included:
   1. Items not included in the Contract shall be shown, for example, by indicating "NIC" (Not in Contract), on the Drawings.
   2. Existing construction, except where such construction is to be removed, replaced, or altered.
   3. Executed items which are not included in the Contract shall not be paid unless ordered and/or approved by the Engineer's Representative.

1.03 CONTRACT AWARD SUBMITTALS

A. Submit the Contractor's List of Subcontractors-Suppliers information required in ADMINISTRATIVE REQUIREMENTS Specification Section 013000 not later than 15 days or as agreed in the Contract Documents after award of the Contract by the Procuring Entity.

B. Submit the Contractor's Progress Schedule information required in ADMINISTRATIVE REQUIREMENTS Specification Section 013000 not later than the days specified in the General Conditions of Contract after award of the Contract by the Procuring Entity.

1.04 RESTRICTIONS

A. Restricted work period: Do not perform any Contract Work during unfavorable situations or conditions that will affect its quality unless approved otherwise, in writing, by the Engineer. Any restrictions indicated in the Contract Documents shall be respected. For example, compaction may not be performed during raining unless protected from excessive moisture.

1.05 CONNECTION TO UTILITY SOURCES

A. Contractor will not be allowed to tie into utility sources until the Engineer or Procuring Entity has reviewed and approved the connection.
   1. Submit written procedures through the Engineer's Representative to the Procuring Entity, detailing how the connection Work is proposed to be performed.
   2. After procedures have been approved, notify the Engineer's Representative at least 3 working days prior to the connection Work so that arrangements can be made to have a Procuring Entity Representative witness the Work.

1.06 CONTRACTOR USE OF PREMISES

A. Contractor has unrestricted use of site except as indicated.

B. Coordinate use of premises under direction of Engineer's Representative.

C. Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

1.07 REFERENCE SPECIFICATIONS AND STANDARDS

A. Comply with the requirements of the various specifications and standards referred to in these Specifications, except where they conflict with the requirements of these Specifications. Such reference specifications and standards shall be the date of latest revision in effect at the time of receiving bids, unless the date is given.

1.08 LAYING OUT

A. Examine the Contract Documents thoroughly and promptly report any errors or discrepancies to the Engineer's Representative before commencing the Work.

B. Lay out the Work in accordance with the Contract Documents.
   1. Layouts, which require the establishment of property lines or monuments, shall be performed by an experienced Surveyor and preferably licensed by the Government of Ethiopia.

SPECIAL INSPECTIONS

A. Contractors are responsible for notifying the Engineers Representative regarding for items that needs special inspections required by the Contract Documents.

B. Where deficiencies are identified, the contractor must take corrective actions to comply with the Contract Documents or remedy the deficiencies in accordance with the requirements of the General Conditions of Contract.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

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SECTION 013000

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Submittals: Section 013300.

B. Project Meetings: Section 013119.

C. Project Schedule: Section 013113.

1.02 CONTRACTORS COORDINATION

A. During construction, coordinate use of site and facilities through procedures of intra-project communications stated in the Contract or as agreed in the pre-construction meeting including coordination for submittals, reports and records, schedules, coordination of drawings, recommendations, and resolution of ambiguities and conflicts.
   1. Coordinate scheduling, submittals, and Work of various Specification Sections to assure efficient and orderly sequence of installation of interdependent construction elements.

B. Subcontractors – Supplier's coordination: Submit the following information not later than 15 days after approval of the Contract or as per the requirement of the Contract Documents unless the Contractor or the Engineer determines an earlier submission is required to properly schedule or progress the Work.
   1. Contractor's list of subcontractors – suppliers: An affirmative review of the subcontractor's responsibility shall be conducted. Any subcontractor disapprovals resulting from negative information derived from the Procuring Entity's review will result in written notice to the Contractor.
      a. Submit the Contractor's list of subcontractors – suppliers information using the form indicated, if any, or as agreed with the Engineer. Transmit a signed original form to applicable bodies to their addresses:
         1) Deliver a copy of the form to the Engineer's Representative at the site.

      b. Indicate the items of Work proposed to be accomplished by the Contract including the Work to be accomplished by subcontractors, the name and address of each proposed subcontractor, the Contract value of the subcontract.
      c. Indicate the names and addresses of proposed suppliers, the contract value of the supplies.
      d. Failure in providing this information may result in payments being withheld and referral to the Procuring Entity for a responsibility determination.

   2. Contractor's progress schedule: Establish the periods of time during which the various segments of the Work of subcontractors – suppliers must be completed in order to complete all of the Work by the physical completion date.
      a. Comply with the requirements of progress schedule preparation submittal date stated in Project Schedule part in this Section.

3. If after initial approval, circumstances require a change in a subcontractor or supplier or require additional subcontractors or suppliers to be used, submit a revised form to reflect the changes or additions.

1.03 CONSTRUCTION PROJECT MEETINGS

A. Comply with the requirements stated in Section 013119:

1.04 PROJECT SCHEDULE

A. Development and updating of the project schedule:
   1. Comply with the requirements stated in Section 013113.
   2. Unless otherwise instructed, the timing used in the schedule shall always refer to Calendar days, weeks or months.
   3. Project schedule shall be prepared and submitted within the time limits given in the Contract Document and in any case not later than the end of the mobilization period. Consideration shall be given to the requirement of the review of the schedule and re-submittal prior to the end of mobilizing period.

B. Maintaining schedule:
   1. Perform the Work in accordance with the Project Schedule and provide resources necessary to maintain the progress of activities as scheduled so that no delays are caused to other Contractors engaged in the Work.
   2. Should any Contractor fail to maintain progress according to schedule or cause delay to another Contractor, that Contractor shall provide such additional manpower, equipment, additional shifts, or other measures as directed to bring the operations back on schedule.

C. Contractor’s representative:
   1. The Contractor shall designate an authorized representative responsible for the Project Schedule including preparation, review and progress reporting with and to the Engineer and Procuring Entity.
   2. The Contractor's representative shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the requirements of this specification section.

1.05 CONSTRUCTION PROGRESS REPORTING

A. Periodic weekly, monthly and quarterly reports shall be submitted by the Contractor to the Engineer and Procuring Entity indicating the progress of works.

B. The monthly progress shall at least indicate:
   1. Activities carried out in the month and the total value of work to-date.
   2. Problems encountered, affected portions of work and their effect on sequential activities.

C. The Quarterly report shall at least indicate:
   1. Activities carried out in the quarter and the total to-date including value of work.
   2. Comparative effect of the activities on the proposed schedule.
   3. Problems encountered and their effect on the succeeding work and overall.
   4. Validity of the float proposed in the schedule.

1.06 ON-SITE DOCUMENTS

A. Maintain at job site, one copy each of the following:
   1. Contract drawings.
   2. Specifications.
   3. Bill of quantities.
   4. Minutes of meetings.
   5. Reviewed shop drawings.
   6. List of outstanding shop drawings.
   7. Change orders.
   8. Other modifications to Contract.
   9. Field test reports.
   10. Copy of approved Work schedule.
   11. Health and Safety Plan and other Safety related documents.
   12. Manufacturers' installation and application instructions.
   13. Other documents as specified.

1.07 PHOTOGRAPHIC DOCUMENTATION

A. Photographs on progress shall be taken by the Contractor at instructed intervals but not less than that required to indicate critical work stages and progress. A minimum of one print of each shall be displayed at site and two copies submitted.

B. Full set of completed Work photographs shall be submitted by the Contractor at the end of the Work. The cost of all such photographs shall be borne by the Contractor.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

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SECTION 013113

PROJECT SCHEDULE

PART 1 GENERAL

1.01 RELATED REQUIREMENTS AND INFORMATION SPECIFIED ELSEWHERE

A. Project Meetings: Section 013119.

B. Administrative Requirements: Section 013000.

C. Submittals: Section 013300.

1.02 DESCRIPTION

A. This section describes the requirements for the preparation, submittal, updating and revision of the Contractor's Project Schedule.

1.03 GENERAL

A. The Contractor's Project Schedule shall be used by the Contractor to plan and execute the Works. The Project Schedule will also be used by the Engineer to monitor progress and be the basis for the assessment of extensions of time and the effect of delay on the progress of the Works.

B. The Project Schedule shall be produced by the Contractor in the following phases:
   1. Initial Project Schedule: *F*or the 1st three months of Work.
   2. Updated Project Schedule. The Accepted Project Schedule shall be updated with actual progress and filled (saved electronically) on at least a monthly basis for record purposes. The Contractor may submit for acceptance by the Engineer other revisions to the Accepted or Updated Project Schedule.

C. Acceptance of the Project Schedule by the Engineer shall not relieve the Contractor from any of his obligation under the Contract.

D. If at any time there is a dispute or difference between the Contractor and Engineer over any matter concerning the Contractor's Project Schedule, then immediate steps should be taken by either party to have the dispute settled in accordance with the appropriate clause of the General Conditions of Contract that sets out the contract dispute resolution provisions.

1.04 SUBMISSION OF PROJECT SCHEDULE

A. Within the time specified in Section 013000 of this Specification, the Contractor shall submit complete Project Schedule with all the information required to the Engineer for acceptance. Consideration shall be given to the requirement of the review of the schedule and re-submittal prior to the end of mobilizing period required by the Engineer for:
   1. Its information an Initial Project Schedule showing the order in which the Contractor proposes to carry out the works anticipated in the first three months following the award of the Contract. The Initial Project Schedule shall have regard

to the Contract completion dates and any other milestones, and/or restraints set out in the Contract.

2. Its review and acceptance a Project Schedule for the whole Contract (incorporating the Initial Project Schedule) showing the order of procedure in which the Contractor proposes to carry out the Works. This Project Schedule becomes the Accepted Project Schedule upon acceptance by the Engineer. The Accepted Project Schedule shall have regard to the contract completion dates and any other milestones, and/or restraints set out in the Contract. Thereafter, if the actual progress does not conform with the Accepted Project Schedule, the Engineer is entitled to require the Contractor to submit to the Engineer for acceptance a revised Project Schedule showing the order of procedure and periods necessary to ensure completion of the Works by the Contract completion dates.

B. The Contractor shall furnish the Method Statement and such other details and information as the Engineer may reasonably require to accept the Project Schedule.

C. The Contractor shall supply the Engineer with an electronic copy of each Project Schedule, together with a printout bar chart or tabular report in a pre-agreed format. All Project Schedules shall be prepared and submitted using the specified or agreed project planning software. The software shall be capable of producing Project Schedules and information that complies with the requirements of this article and shall be in a format that can be read by commercially available proprietary planning software.

D. Acceptance procedure of the Project Schedule:
   1. The Engineer will have the right to accept the Project Schedule or give its reasons for not accepting the Project Schedule.
   2. If such reasons are given, the Contractor shall take account of the reasons and resubmit the Project Schedule within a period of 10 working days.
   3. If the Engineer does not accept or reject the Project Schedule within 15 working days, the Engineer shall be deemed to have accepted the Project Schedule as submitted.

1.05 DEFAULT IN SUBMISSION OF PROJECT SCHEDULES

A. Should the Contractor fail to submit a Project Schedule for acceptance as the Accepted Project Schedule in accordance with (1.04 A) above, or not regularly update the Accepted Project Schedule as an Updated Project Schedule, the Engineer shall be entitled to reduce percentage of the amount, stated in the Conditions of Contract, due to the Contractor interim payment certificates until the Contractor has complied with its obligations in respect of the Project Schedule.

B. In the event that the Contractor does not submit to the Engineer a Project Schedule for acceptance as the Accepted Project Schedule in accordance with (1.04 A) above or does not regularly update the Accepted Project Schedule as an Updated Project Schedule, the Contractor may lose his right to justify any delay that require the Project Schedule as a basis for claiming Extension of Time or related monetary compensation.

1.06 PREPARATION OF PROJECT SCHEDULE

A. The Initial Project Schedule shall show the first three months' work in the same level of detail as is required for the Accepted Project Schedule set out in paragraph (1.06 C – 1) below, but only insofar as it applies to the first three months of the Contract Period.

B. The Initial Project Schedule shall also be presented as a Project Schedule in bar chart form showing the detailed activities in the period covered by the network diagram, together with the major activities and milestones in the remainder of the period of the Contract. The Initial Project Schedule shall be presented as or be accompanied by the schedules referred to (1.06 C – 2) and, if necessary, (1.06 C – 3) below.

C. The Accepted Project Schedule:

1. The Project Schedule submitted by the Contractor in accordance with (1.04 A) above becomes the Accepted Project Schedule upon acceptance by the Engineer. The Accepted Project Schedule shall form the Contractor's basic strategy for the completion of the Works by the contract completion date. The Project Schedule to be accepted may either be at the direction of the Engineer in a linked bar chart format or precedence network format prepared using techniques acceptable to the Engineer and shall show as far as reasonably practicable:
   a. The activities in all Work packages including those by the principal sub-contractors and Suppliers and those Contractors and Suppliers directly employed by the Procuring Entity.
   b. The earliest and latest start and finish dates for every activity in each work package. Activities shall include all scope activities and any activities or time durations expected in addition to scope activities.
   c. Access dates for each phase or section.
   d. The earliest and latest start and finish dates for each phase or section, including dates when the Contractor plans to complete work to allow the Employer and others to do their Work.
   e. Milestone and Key Dates.
   f. Holiday periods.
   g. Dates by which design work or drawings to be produced by the Contractor or sub-contractors or suppliers will be submitted to the Engineer for acceptance and dates by which acceptance of such design work or drawings will be required by the Contractor, allowing time for submittals, re-submittals and reviews.
   h. Dates by which samples to be produced by the Contractor will be submitted for approval by the Engineer and dates by which approval of such samples will be required by the Contractor, allowing time for submittals, re-submittals and reviews.
   i. Procurement periods and delivery dates for the major items of goods, plant and materials.
   j. Dates by which work will be ready for testing by the Engineer /Procuring Entity.
   k. Details and dates of any information required from the Employer.
   l. The work contained in defined Provisional Sums.
   m. Activities representing the likely work content of undefined Provisional Sums, complete with logic links but with durations set to zero (unless specified otherwise).
   n. Commissioning periods.
   o. Provisions for float, time risk allowances, quality control procedures, health and safety requirements and any other requirements that may be set out in the Contract.

2. The Accepted Project Schedule shall also be presented as schedules showing an analysis of the network including:

a. A schedule of all activities tabulated in order of earliest starting date and showing for each activity:
   1) Activity number and brief description.
   2) Preceding and succeeding activity numbers.
   3) Duration.
   4) Earliest and latest starting and finishing dates.
   5) Total and Free float.

b. A schedule of leads and lags with (if requested by the Engineer /Procuring Entity) reasons for them. Excessive leads and lags, negative lags or open/hanging activities, use of fixed dates and any other programming activities that can have the effect of creating false criticality or inhibiting the Project Schedule from reacting dynamically to change should be avoided.

c. A schedule of all activities lying on the paths containing the least float, namely the critical activities.

d. A schedule identifying the days of working per week, shifts per working day and holidays.

e. A schedule giving details of the Contractor's resource requirements in terms of manpower, gang sizes, tradesmen, work rates, items of plant or equipment and materials and quantities of work allowed for in sufficient detail to explain the Contractor's activity durations. Activities that may be the Contractor's activity durations. Activities that may be expedited by use of overtime, additional shifts or any other means shall be identified and explained.

3. The Accepted Project Schedule shall also be presented with or be accompanied by the following schedules.
   a. A schedule of all submittals and material procurement activities, including time for submittals, re-submittals and reviews and time for fabrication and delivery of manufactured products. The interdependence of procurement and construction activities shall be included in the schedule.
   b. A schedule giving the monetary value of each activity for cash flow purposes. The sum of the monetary values shall total the Contract amount. The schedule shall also give the payment items applicable to the activity monetary values.
   c. A schedule giving the information stated in (1.06 C – 4) below.

4. The Accepted Project Schedule shall be prepared in sufficient detail to ensure the adequate planning, execution and monitoring of the work. Activities should generally range in duration up to 28 calendar days (single trade activities with uniform rates of progress might be accepted) and the number of activities with duration of less than seven calendar days should be kept to a minimum to make progress monitoring on larger projects more manageable.
5. The Accepted Project Schedule shall take into account all time risk allowances, including time for the weather conditions (rain) reasonably to be anticipated by the Contractor. The Contract time has been defined on the assumption that the weather conditions will conform to at least a 5 year average of the conditions prevailing at the Site. The Contractor shall provide this data and a summation of the assumed number of adverse weather days per month to the Engineer with the Project Schedule.
6. The Engineer is entitled to withhold its acceptance of a Project Schedule showing the work completed earlier than the contract completion date if that Project Schedule is reasonably considered by the Engineer to be not achievable.

1.07 METHODS OF CONSTRUCTION AND TEMPORARY WORKS

A. At the same time as the Contractor submits the Project Schedule in (1.06 C – 1) or such other time as may be specified in the Contract, the Contractor shall submit to the Engineer for its acceptance a general description of the arrangements and methods of construction and Temporary Works designs the Contractor proposes to adopt for the carrying out of the Works ('the Method Statement'). The Method Statement should be fully cross-referenced to the activities in the Project Schedule.

B. The Contractor shall submit to the Engineer sufficient information as may be considered reasonably necessary by the Engineer to interpret, evaluate and give acceptance to the Method Statement.

C. The Contractor shall, whenever required by the Engineer, furnish for its information further and more detailed particulars of the Contractor's method statement.

D. Should the Contractor wish to change a method statement or should the Engineer subsequently consider it necessary to change a method statement to which acceptance has previously been given, then the Contractor shall submit a revised method statement to the Engineer for its acceptance.

E. Acceptance by the Engineer of the Contractor's Method Statement does not make the Method Statement a contract document, or mandate that the Works shall be constructed strictly in accordance with the Method Statement. The Contractor at all times remains responsible for the construction of the Works in accordance with the clause of the conditions of contract that sets out the Contractor's basic obligations.

1.08 CASH FLOW ESTIMATES

A. Within four weeks of the award of the Contract or such other time as may be specified in the Contract Documents, the Contractor shall submit to the Engineer for its information a detailed cash flow estimate, in quarterly periods, of all payments to which the Contractor considers it will be entitled to under the Contract. The Contractor shall subsequently submit such revised cash flow estimates at quarterly intervals based on the Updated Project Schedule, if required by the Engineer.

1.09 REVISING AND UPDATING THE PROJECT SCHEDULES

A. The Accepted Project Schedule:
   1. The Accepted Project Schedule (or, if the Accepted Project Schedule has already been updated, the Updated Project Schedule) and the corresponding Method Statement if required by the Engineer shall be revised by the Contractor within 10 working days of the Contractor changing its methods and/or sequences of working or, if the changes are frequent, revised at least every month. The Project Schedule shall also be revised within 10 working days of the grant by the Engineer of an extension of time, or whenever circumstances arise that in the opinion of the Engineer affect the progress of the Works. Each revision to the Project Schedule shall be submitted to the Engineer for its review and acceptance Once a revised Project Schedule is accepted by the Engineer, it replaces the previously Accepted or Updated Project Schedule.

2. Each revised Project Schedule submitted for acceptance shall be presented as or be accompanied by the schedules referred to in (1.06 C – 2) and, if necessary, (1.06 C – 3) above, together with any amendments to the method statement.

B. The Updated Project Schedule:
   1. The Accepted Project Schedule shall be updated for actual progress at least once every month and the updates shall be archived as separate electronic files for record purposes. The updates shall be to all scope activities and any additional activities carried out or time durations experienced in addition to the scope activities. Actual progress shall be recorded by means of actual start and actual finish dates for activities, together with percentage completion and/or remaining duration of currently incomplete activities. Any periods of suspension of an activity should be noted in the Updated Project Schedule. Each Updated Project Schedule shall be submitted to the Engineer for its acceptance as a record. It is possible (if the Works have been delayed) that these Updated Project Schedules will show completion later than the contract completion dates. In this event the Engineer's acceptance of such Project Schedules will not constitute acceptance of the delay(s).
   2. The Updated Project Schedules will be used by the Engineer to monitor the Contractor's performance against the Accepted Project Schedule, forecast work to be performed in the subsequent period and to assess extensions of time at the time the cause of delay occurs. In order to provide effective monitoring of performance, the Contractor shall also provide to the Engineer the progress.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 013119

PROJECT MEETINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes the requirements for construction project meetings starting from pre-construction meeting to closeout meeting.

1.02 PRE-CONSTRUCTION MEETING

A. Pre-construction meeting shall be held before the start of construction. This meeting is important for establishing the desired attitude and direction for the entire construction process.

B. The Engineer shall schedule pre-construction meeting and notify all parties concerned of the time and place of the pre-construction meeting.

C. The Engineer or Engineer's Representative preside the meeting.

D. Attendance Required: Procuring Entity's representatives, Designers, special consultants as required by Engineer or Engineer's Representative, Contractor and/or Contractor's Representatives, and major Subcontractors and Suppliers.

E. During Pre-construction meeting, the following shall be reviewed and clarified:
1. Individuals who represent the parties to the Contract.
2. Individuals who have contractual authority to sign change orders and make binding decisions.
3. Responsibilities of the parties to the Contract.
4. Lines of communication.
5. Duties of project personnel.
6. Submission requirements for the list of subcontractors, materials, equipment, and named products.
7. Procedures for measurement and payment, including the schedule of values and applications for payment.
8. Procedures for contract modifications, including supplemental instructions, field orders, change directives, proposal requests, and change orders.
9. Preliminary schedule, construction progress schedule, and submittal schedule.
10. Importance of complete, correct, and timely submittals, as well as scheduled dates.
11. Review of insurance.
12. Procedures and processing of Shop Drawings, substitutions, Contract closeout and other submittals.
13. Scheduling of the Work and coordination with other contractors.
14. Review of Subcontractors and Suppliers.
15. Appropriate agenda items listed for the site mobilization meeting when pre-construction meeting and site mobilization meeting are combined.
16. Requirements for quality control, quality assurance, and informational submittals.
17. Product options and substitutions permitted, and explanation of the ground rules and procedures associated with them.

18. Procedures for testing and inspection, including timely notification when the Work is ready for testing and inspection.
19. Responsibilities and limitations of authority of an inspection service or laboratory, and distribution of reports.
20. Procedures for field decisions and filing claims.
21. Procedures for maintaining record documents.
22. Maintaining construction tolerances.
23. Procedures for requests for interpretations.
24. Schedule for project meetings.
25. Any other issues.

1.03 SITE MOBILIZATION MEETING

A. Site mobilization meeting:
   1. When required by Contract documents, the Engineer or Engineer's Representative will schedule a meeting at the Project site prior to Contractor mobilization.
   2. The Engineer or Engineer's Representative preside the meeting.
   3. Attendance Required:
      a. Procuring Entity's representatives, Designers, special consultants as required by Engineer or Engineer's Representative, Contractor's Representative, and major Subcontractors.

   4. Agenda:
      a. Use of premises by the Procuring Entity and Contractor.
      b. Safety and first aid procedures.
      c. Construction controls provided by the Procuring Entity.
      d. Temporary utilities.
      e. Survey and layout.
      f. Security and housekeeping procedures.
      g. Field office requirements.
      h. Any other issues.

1.04 UTILITY COORDINATION MEETING

A. On a project including significant utility work, or where significant utility relocation work is required, utility coordination meeting shall be held shortly after the preconstruction meeting. The following issues that shall be addressed, as appropriate, at the utility meeting:
   1. Identifying the best time for each utility provider to perform their work.
   2. Identifying the interface with other utility providers for work that must occur concurrently.
   3. Establishing how long each utility provider's work will take.
   4. Identifying the primary contact person.
   5. Establishing how much notification (lead time) each utility provider will require to mobilize.
   6. Identifying whether there are related costs that have not been identified.
   7. Determining or confirming who will do the locating work for each utility provider.
   8. Identifying special inspection requirements. Regardless of the project extent, a utility coordination meeting might be required by utility providers as a precondition of future connection to utilities.
   9. Any other issues.

1.05 PROGRESS MEETINGS

A. Monthly progress meetings:
   1. Hold meetings at Project field office or other location designated by Engineer or Engineer's Representative.
   2. The Engineer or Engineer's Representative, as appropriate, preside the meeting.
   3. The Engineer or Engineer's Representative will provide required information and be prepared to discuss each agenda item.
   4. Attendance Required: Contractor's Representative, major Subcontractors and Suppliers, Procuring Entity's representatives, Designers as appropriate for agenda topics for each meeting.
   5. Agenda:
      a. Review minutes of previous meetings
      b. Review also minutes of bi-weekly meetings.
      c. Review of construction schedule, pay estimates, cash flow curve, and compliance submittals.
      d. Field observations, problems, and necessary decisions.
      e. Identification of problems that impede planned progress.
      f. Review of submittal schedule and status of submittals.
      g. Modification status.
      h. Review of off-site fabrication and delivery schedules.
      i. Maintenance of Construction Schedule.
      j. Corrective measures to regain Construction Schedule.
      k. Planned progress during the succeeding work period.
      l. Coordination of projected progress.
      m. Maintenance of quality and work standards.
      n. Any other issues related to the construction Works.
      o. Any other issues.

B. Bi-weekly job meetings:
   1. Unless otherwise directed, job meetings will be held every two weeks at a time and place agreed upon by the Engineer's Representative, the Contractor's Representative, and the Procuring Entity's Representative. Other interested parties may attend when needed, e.g., subcontractors and representatives from suppliers, public utilities, and local government.
   2. The meetings will be conducted by the Engineer's Representative for the following purposes:
      a. Review job progress, quality of Work, and approval and delivery of materials.
      b. Identify and resolve problems which impede planned progress.
      c. Coordinate the efforts of all concerned so that the project progresses on schedule to on time completion.
      d. Maintain a sound working relationship between the Contractor and the Engineer's Representative and a mutual understanding of the project requirements.
      e. Maintain sound working procedures.
      f. Any other issues.

1.06 PRE-INSTALLATION MEETINGS

A. Pre-installation meetings will be held to review the specifications, drawings and approved submittals in preparation for start of a particular activity.

B. The meetings shall be attended by the Engineer's Representative, a Design Representative and the Contractor's Representative including installer and representatives of manufacturers & fabricators involved in or affected by the installation and its coordination with other materials/trades.

C. The Engineer's Representative shall schedule the meetings prior to the start of the work and preside the meeting. The goal of these meetings is to ensure the quality of construction and to maintain the schedule.

1.07 CLOSEOUT MEETING

A. The closeout meeting shall be used to review requirements for the completion of the Contract and to obtain submittal of the necessary final documents. The following issues, as appropriate, shall be addressed during closeout meeting:
   1. Starting systems.
   2. Testing, adjusting, and balancing.
   3. Demonstration and training.
   4. • Contractor's inspection of work.
   5. • Contractor's preparation of an initial punch list.
   6. Procedure to request Engineer's Representative inspection to determine the date of substantial completion.
   7. Completion time for correcting defective work.
   8. Certificate of use or occupancy and transfer of insurance responsibilities.
   9. Partial release of retain-age.
   10. Final cleaning.
   11. Preparation for final inspection.
   12. Closeout submittals.
   13. Record documents.
   14. Maintenance materials.
   15. Product warranties.
   16. Affidavits.
   17. Final application for payment.
   18. Contractor's demobilization of site.
   19. Operation and maintenance data.

1.08 PRE DEFAULT MEETING

A. Pre default meeting shall be conducted in the case where there is a default by the Contractor for terminating the Contract. The Procuring Entity will have a demand upon a surety to claim under the terms of the performance bond. The surety will investigate the Procuring Entity's claim against the contractor.

1.09 ATTENDANCE REQUIREMENTS

A. A Contractor's Representative shall be required to attend all meetings scheduled by the Engineer or Engineer's Representative.

B. The Contractor's Representative shall be a competent supervisor familiar with the work and have authority to act for the Contractor.

C. If the Contractor's Representative fail to attend 2 scheduled meetings without prior approval, the Contractor will be directed to replace the current Contractor's

Representative. Further incidents of non-attendance by the Contractor's Representative, will form the basis for review of the Contractor's responsible bidder status.

1.10 MINUTES OF MEETINGS

A. The Engineer's Representative records the minutes of meetings and distributed to the participants.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

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SECTION 013300

SUBMITTALS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Other requirements pertaining to Submittals are included in the General Conditions of Contract and in the various Sections of these Specifications.

B. Administrative Requirements: Section 013000.

C. Execution and Closeout Requirements: Section 017000.

1.02 DEVIATIONS FROM REQUIREMENTS OF THE CONTRACT DOCUMENTS

A. Deviations from the requirements of the Contract Documents shall not be allowed unless a request for deviation is made in writing prior to or at the time of submission and the specific deviation is approved by the Engineer's Representative subject to the requirements of the General Conditions of Contract.
   1. The submission of a deviation shall be done in a timely manner according to the schedule of Submittals to allow the Engineer sufficient time for review.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Identify all Submittals by project title and number. Include Contractor's name, date, and revision date. On shop drawings, product data and samples, also include the name of the supplier and subcontractor (if any), and applicable specification section number.
   1. Stamp each Submittal and initial or sign the stamp to certify review and approval of Submittal.

B. Assemble Submittals in accordance with the requirements in the individual sections of the Specifications and as required by this Section.
   1. It is the Contractor's responsibility to review and verify that all information required for each Submittal is included in the submittal package.
      a. Errors or omissions found by the Contractor are to be corrected prior to the submission of the submittal package for approval.
      b. Incomplete Submittal packages that have been submitted for review and approval will be returned.

   2. It is the Contractor's responsibility to verify that portions of the Submittal package to be provided by a subcontractor (or supplier) are complete, as well as portions of the submittal package being provided directly by the Contractor.
   3. Do not combine the Submittals of more than one Specification Section with Submittals required by other Specification Sections unless specifically stated in the Contract specifications.

C. If a Submittal is based on, or the result of, a change order or field order to the Contract Documents, include copies of the applicable change order or field order with the Submittal.

1.04 RE-EVALUATION COST

A. A re-evaluation processing cost, if any, for each re-evaluation of any Submittal Package submission that was returned for failure to comply with the submittal requirements relative to completeness, content or format shall be covered by the Contractor.

1.05 PAPER AND ELECTRONIC SUBMITTALS

A. General:
   1. The minimum acceptable qualities of materials and workmanship have been established in this Specification by Reference to accepted Standards, Codes or descriptions of required performance. Requirements have been established in each Section for the advance submittal of data for review and approval. Such required data shall be submitted and reviewed and resubmitted as frequently as required until compliance with the specific requirements has been obtained.
   2. Two copies of paper and electronic submittals shall be submitted to the Engineer for review and approval.
      a. At least one package of the paper submittals shall be originally signed and sealed by the contractor.
   3. Each data of Submittal shall be reviewed and verified for its compliance with the specific requirements of the Submittals called for in each Section of this Specification.
   4. Approval of Submittals shall not absolve the Contractor from replacing, the material supplied or work executed, if the materials and workmanship are found defective by tests carried out thereafter. Such materials found to be defective, shall be replaced at no cost to the Procuring Entity.
   5. All paper submittals shall accommodate one original copy having signed and sealed by the Contractor in addition to the necessary photo copies.
   6. All data, samples, test results, certificates, designs, drawings, etc., to be submitted shall fully comply with the requirements as specified in each Section of this Specification.
   7. Data and document accompanying samples of materials for submittals shall be signed by the Contractor as proof of their being submitted for the specific work under consideration.
   8. The document shall bear, the date, reference of Section to this Specification and other requirement as specified in the particular Sections of this Specification.
   9. Schedules of submittals required by the Technical Specification shall be prepared and submitted both in paper and electronic (CD, DVD, or USB flash drive) of two copies immediately after the signature of agreement.
   10. Timing of submittals:
      a. All Submittals and requests for substitutions shall be made in advance allowing sufficient time for inspection, testing review and verification. They shall be submitted in such a way that enough time is left after approval for the placement of order, delivery, manufacture, etc., prior to the time for installation in accordance with the work schedule.
      b. Submittals shall always be in groups as far as possible.

B. Electronic Submittals:
   1. Project paper submittals (shop drawing, product data and quality assurance submittals) shall be scanned and converted to Portable Document Format (PDF) by

the Contractor, unless other methods are specified or directed otherwise, and submitted to the Engineer for review and approval. After the submittal is reviewed and approved, it is documented and available in the project site for action or use by the Contractor and Engineer's Representatives.

2. It is the Contractor's responsibility to provide the submittals in a PDF format. The contractor may use any of the following options:
   a. Subcontractors and suppliers provide and submit electronic submittals in PDF format via the Contractor.
   b. Subcontractors and suppliers provide paper submittals to the Contractor, who electronically scans and converts them to PDF format.
   c. Contract a Scanning Service, which will allow the Contractor and the Contractor's subcontractors and suppliers to provide paper submittals to the Scanning Service, which electronically scans and converts them to PDF format. It will be the Contractor's responsibility to transmit the scanned submittals to the Engineer.

3. Image Quality:
   a. Image resolution: The PDF files shall be created at a minimum acceptable resolution and utilizing the original document size to adequately present the information.
   b. Image Color Rendition: When information represented requires color to convey the intent and compliance, provide full color PDF reproduction.

C. Paper prints (hardcopies) of reviewed submittals:
   1. Record Copy: Within 14 days of receipt of approval of submittals the Contractor shall provide one paper copy of the submittal they are responsible for to the Engineer's Representative.
      a. Paper copies shall be printed in a size format equal to the original document.
      b. Scaled Shop Drawings shall be printed to the scale noted on the drawings.
      c. The resolution of the printed copy shall be equal to that of the PDF file that it is being printed from.
      d. The Record Copy shall be used by the Engineer's Representative during the construction of the project and shall be retained as a turn-over item to the facility at the end of the project as required section 017716 Contract Closeout.

   2. Contractor Copies: The Contractor will be responsible for making copies, for the Contractors own use and for use by its subcontractors and suppliers.

D. For each submittal, the Contractor shall review and apply stamp and sign on paper submittals certifying that the submittal complies with the requirements of the Contract Documents, including verification of manufacturer/product, dimensions and coordination of information with other parts of the work.

E. Project Closeout:
   1. At completion of the project a minimum four sets of all submittal documents shall be delivered to Engineer or Procuring Entity both in paper and electronic copies.

1.06 SHOP DRAWINGS

A. Provide shop drawings in the format required by the specifications. Show the information, dimensions, connections and other details necessary to insure that the shop drawings accurately interpret the Contract Documents. Show adjoining construction in

such detail as required indicating proper connections. Where adjoining connected construction requires shop drawings or product data, submit such information for approval at the same time so that connections can be accurately checked.

B. Have shop drawings prepared by a qualified detailer. Shop drawings shall be neatly drawn and clearly legible. Machine duplicated copies of Contract Drawings will not be accepted as shop drawings.
   1. Where shop drawings are indicated to be drawn to scale:
      a. Use scale normally found on an "Architect" or "Engineer" scale.
      b. Written Scale: Clearly label scales being used on each drawing and/or on each detail on the drawing.
      c. Graphic Scale: Adjacent to each Written Scale, provide a graphic scale delineating the scale being used. Graphic scale shall be divided into measuring units relating to the accuracy required for the drawing or details.
      d. Clearly dimension key elements of the drawing or detail.

   2. When the drawing sheet is printed full size, requirements shall be maintained for the minimum text size for hand drafting and for CADD drawings.

C. Submit the shop drawings Submittals to the Engineer both in paper print and electronic. The shop drawings will be reviewed and the review results will be returned to the Contractor. If the review results in disapproved, promptly correct the deficiencies and resubmit the shop drawings meeting Contract requirements.

1.07 PRODUCT DATA

A. Provide product data in the format required by the specifications. Modify product data by deleting information that is not applicable to the project or by marking the product data to identify pertinent products. Supplement standard information, if necessary, to provide additional information applicable to project.

B. Submit the product data Submittals to the Engineer both in paper print and electronic. The product data will be reviewed and the review results will be returned to the Contractor. If the review results in disapproved, promptly correct the deficiencies and resubmit the product data meeting Contract requirements.

1.08 QUALITY ASSURANCE

A. Provide quality assurance information including supporting documentation as required.

B. Submit the quality assurance information Submittals to the Engineer both in paper print and electronic. The quality assurance information will be reviewed and the review results will be returned to the Contractor. If the review results in disapproved, promptly correct the deficiencies and resubmit the quality assurance information meeting Contract requirements.

1.09 SAMPLES

A. Submit 2 (unless a different number is specified) of each sample with letter and supporting documents required by the Specifications.

B. Samples will become the property of the Procuring Entity when submitted and will not be incorporated in the Work unless specifically stated otherwise.

C. The electronic submittal process is not intended for color samples, color charts, or physical material samples.

D. Consult with the Engineer's Representative for direction on where Samples will be sent for review.

E. The sample will be reviewed and the review results will informed to the Contractor.

F. Rejected samples shall be removed from site immediately upon receipt of instruction.

G. No material or workmanship requiring sample approval shall he delivered or executed prior to obtaining approval of the samples.

1.10 REVIEW OF SUBMITTALS

A. Items submitted for review will be reviewed for compliance with the contract documents, based upon the information submitted. The items will be acted upon with the following dispositions:
   1. Approved: Where the Submittal gets approval, the Work covered by the Submittal may proceed provided it complies with the Contract Documents. Final acceptance will depend on that compliance.
   2. Approved as Noted (or Make Corrections Noted): Where the Submittal is approved as Noted, the work covered by the submittal may proceed provided it complies with the review comments noted on the submittal and the Contract Documents. Final acceptance will depend on that compliance.
   3. Disapproved (or rejected): Where the Submittal gets disapproval, do not proceed with the work covered by the submittal, including purchasing, fabrication, delivery or other activity for the item submitted. Prepare a new submittal according to the review comments noted on the submittal and meeting the Contract Documents.
   4. Returned for Correction (or Revise and Resubmit): Where the Submittal is returned for correction, do not proceed with the work covered by the submittal, including purchasing, fabrication, delivery or other activity for the item submitted. Revise or prepare a new submittal according to the review comments noted on the Submittal and meeting the Contract Documents.
   5. Acknowledged: Where the Submittal acknowledgement, receipt of the Submittal is acknowledged and has been recorded.

1.11 SCHEDULES AND RECORDS

A. Submit submittals and record Schedules not later than 15 days after approval of the Contract unless the Contractor or the Engineer determines an earlier submission is required to properly schedule or progress the Work.
   1. Schedule of Submittals: The submission date that is entered shall provide sufficient time for the item to be reviewed, ordered, delivered and installed for timely completion of the Work in accordance with the Project Schedule.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 014100

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 COMPLIANCE

A. Comply with applicable Regulatory Requirements and various Codes referenced in these specifications. Where conflicts exist between Regional, and/or Federal Regulatory Requirements, Codes, or these specifications, request advice from the Engineer. The Engineer will assist in resolving the conflicts to the satisfaction of the regulatory agencies prior to commencing the Work.

1.02 CODES

A. Ethiopian Building Standard Codes: All Contract Work shall comply with the following listed Ethiopian Building Codes and their Referenced Standards. The referenced Codes shall be the date of latest revision in effect at the time of receiving bids, unless the date is given.
   1. EBSC – 1: Basis of Design and Actions on Structures.
   2. EBSC – 2: Structural Use of Concrete.
   3. EBSC – 3: Design of Steel Structures.
   4. EBSC – 4: Design of Composite Steel and Concrete.
   5. EBSC – 5: Utilization of Timber.
   6. EBSC – 6: Design of Masonry Structures.
   7. EBSC – 7: Foundations.
   8. EBSC – 8: Design of structures for Earthquake Resistance.
   9. EBSC – 9: Plumbing services of building.
   10. EBSC – 10: Electrical Installation of buildings.
   11. EBSC – 11: Ventilation and Air Conditioning of buildings.
   12. EBSC – 12: Architectural Design Code of buildings.
   13. EBSC – 13: Fire Protection Code of buildings.
   14. EBSC – 14: Health and Safety Code of buildings.

1.03 PROCLAMATIONS

A. All Contract Work shall comply with the Ethiopian Building Proclamation (Proclamation No. 624/2009), the Ethiopian Building Regulation (Regulation No. 243/2011) and their Directives.

B. Comply with the following Ethiopian Proclamations and Regulations applicable for Environmental and Health and Safety issues:
   1. Environmental Pollution Control Proclamation No. 300-2002.
   2. Forest Development Conservation and Utilization Proclamation No. 542-2004.
   3. Solid Waste Management Proclamation No 513-2007.
   4. Environmental Impact Assessment Proclamation N0. 299-2002.
   5. Labour Proclamation No 377/2003.
   6. Labour (Amendment) Proclamation No 466/2005.
   7. Labour (Amendment) Proclamation No 494/2006.
   8. Convention on Forced or Compulsory Labour Ratification No 336/2003.

1.04 UTILITIES

A. Underground Utilities:
   1. Locate existing underground utilities prior to commencing excavation work. Conform to all requirements of concerned bodies, including the following:
      a. Determine exact utility locations by hand excavated test pits. Contractor will be responsible for the proper support and protection of all utilities to remain in service.

B. Coordination with EEPCO:
   1. Comply with EEPCO requirements for the incoming electric service connection system and other concerning issues, such as wiring, power, etc.

C. Coordination with Municipality for Water Connection:
   1. Comply with the municipal requirements for the connection of water lines to the municipal utility services. Obtain all necessary permits from municipal water department. Obtain authority to connect to their existing water mains.

D. Coordination with Municipality for Sanitary Sewer Connection:
   1. Comply with the municipal requirements for the connection of sanitary sewer lines to the municipal utility services. Obtain all necessary permits from municipal sewer department. Obtain authority to connect to their existing sanitary sewers.

E. Coordination with Telecommunication Organization:
   1. Contact the concerned Ethiopian Telecommunication office and arrange for the removal and relocation of existing telephone/telecommunication equipment.

F. Utility Work within roads Right-Of-Way:
   1. Utility Work, either overhead or underground, within the boundaries of the roads Right-Of-Way, shall conform to the rules, regulations and procedures of the Regional or Federal Government.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 014200

REFERENCES

PART 1 GENERAL

1.01 REFERENCES SPECIFIED ELSEWHERE

A. Other References are included in the General Conditions of Contract, Contract Documents and in various Sections of this Specifications.

1.02 QUALITY ASSURANCE

A. Conform to the latest Reference Standard by date of issue unless clearly specified in the Contract Documents.

B. Request clarification from the Engineer before proceeding should Specified Reference Standards conflict with Contract Documents.

1.03 ABBREVIATIONS

A. The words and terms for abbreviations used in this Specifications are described in the following table:

ABBREVIATIONS	TERM
-A-	
A	Ampere
AC	Alternating Current
AC	Air Conditioner
ACV	Aggregate Crushing Value
AVG	Average
AWG	American Wire Gauge
-B-	
-C-	
CAD	Computer Aided Design
CBR	Californian Bearing Ratio
CCS	Cross Connection Systems
CCTV	Closed Circuit TV
CO	Central Office (Telecommunication)
CPU	Central Processing Unit
-D-	
DIA	Diameter

ABBREVIATIONS	TERM
°C	Degree Centigrade
dB	Decibel
DB	Distribution Board
DC	Direct Current
-E-	
EEPCO	Ethiopian Electric Power Corporation
E.G.	For Example
EMI	Electromagnetic Interference
EPBX	Electronic Private Branch Exchange
ESA	Ethiopian Standards Agency
-F-	
FA	FireAlarm
FACP	Fire Alarm Control Panel
F(µF)	Farads (Micro-Farads)
-G-	
GCC	General Conditions of Contract
GFCI	Ground Fault Circuit Interruptor
-H-	
HCC	Horizontal Cross Connection
HCCS	Horizontal Cross Connection Subsystem
HVAC	Heating, Ventilating and Air Conditioning
Hz	Hertz
-I-	
IDC	Insulation Displacement Connector
IEC	International Electro-technical Commission
IMCCS	Intermediate Cross Connection Subsystem
IMTC	Intermediate Telecommunication Cabling
ISO	International Organization for Standardization
-J-	
-K-	
KM	Kilometer
kW	Kilo-watt
KWh	Kilo-Watt hour
KWHM	Kilo-Watt hour meter
-L-	
L	Length
LAN	Local Area Network
LED	Light Emitting Diode

ABBREVIATIONS	TERM
-M-	
M	Meter
MATV	Master Antenna TV
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MCCS	Main Cross Connection Subsystem
MM	Millimeter
MTC	Main Telecommunication Cabling
-N-	
-O-	
OEM	Original Equipment Manufacturer
-P-	
PA	Public Address
PVC	Polyvinil Chloride
PVC-U	Un-plasticized Poly (Vinyl Chloride)
PE	Polyethylene
PE-HD	High-Density Polyethylene
PI	Plasticity Index
PM	Plasticity Modulus
PP	Polypropylene
-Q-	
QA	Quality Assurance
QC	Quality Control
-R-	
RCBO	Residual Current Device with Overcurrent Protection
RCCB	Residual Current Circuit Breaker
RCD	Residual Current Device
RTC	Riser Telecommunication Cabling
-S-	
SCC	Special Conditions of Contract
SQ.	Square
STP	Shielded Twisted Pair
-T-	
TC	Telecommunication Closet
TCO	Telecommunication outlet
TFV	Ten percent Fines Value

ABBREVIATIONS	TERM
-U-	
UTP	Un-shielded Twisted Pair
-V-	
V	Volt
VA (KVA)	Volt-Ampere (Kilo –Volt-Amprere)
VAr(KVAr)	Reactive Volt-Ampere (Reactive Kilo-Volt-Ampere)
VCC	Vertical Cross Connection
VCCS	Vertical Cross Connection Subsystem
VOC	Volatile Organic Compound
-W-	
W	Watt
WAN	Wide Area Network
-X-	
XLPE	Cross Linked Poly-Ethylene
-Y-	

1.04 DEFINITIONS

A. The following terms shall have the meanings ascribed to them in this Section, wherever they appear in the Specifications.
   1. Bill of Quantities: The document forming part of the Bid and containing an itemized breakdown of the works to be carried out in a unit price contract, indicating a quantity for each item and the corresponding unit price.
   2. Contract Documents: The documents listed in the GCC, including all attachments, appendices, and all documents incorporated by reference therein, and shall include any amendments thereto.
   3. Contract Price: The accepted Contract amount stated in the Procuring Entity's Letter of Acceptance. The amount represents the initial estimate payable for the execution of the Works or such other sum as ascertained by the final statement of account as due to the Contractor under the Contract.
   4. Contract: The binding Contract Agreement entered into between the Procuring Entity and the Contractor, comprising Contract Documents referred to therein, including all attachments, appendices, and all documents incorporated by reference therein.
   5. Contractor: A natural or juridical person under contract with a Procuring Entity to supply Works.
   6. Day: Calendar day.
   7. Day-works: Varied work inputs subject to payment on an hourly basis for the Contractor's employees and equipment, in addition to payment for associated materials and plants.
   8. Defect: Any part of the Works not completed in accordance with the Contract.

9. Drawings: The drawings of the Works, as included in the Contract, and any additional and modified drawings issued by (or on behalf of) the Procuring Entity in accordance with the Contract, include calculations and other information provided or approved by the Engineer for the carrying out of the works.
10. Engineer: A person named in the Special Conditions of Contract or appointed as such by the Procuring Entity and notified in writing to the Contractor to act as the representative of the Procuring Entity to supervise and inspect works and to test and examine the materials employed and the quality of workmanship, including any authorized representative of such person.
11. Equipment: The Contractor's machinery, vehicles, apparatus, components and any other articles brought temporarily to the Site to construct the Works.
12. Final Acceptance Certificate: Certificate(s) issued by the Engineer to the Contractor at the end of the Defects Liability Period stating that the Contractor has completed its obligations to construct, complete, and maintain the Works concerned.
13. General Conditions of Contract: The general contractual provisions setting out the administrative, financial, legal and technical clauses governing the execution of the Contract, except where amended by the SCC or Contract Agreement.
14. Government: The Government of the Federal Democratic Republic of Ethiopia.
15. Materials: All supplies, including consumables, used by the Contractor for incorporation in the Works.
16. Procuring Entity: Public body, which is partly or wholly financed by the Federal Government Budget, higher education institutions, and public institutions of like nature which has the powers and duties to conclude a Contract for the supply of Works, as specified in the SCC.
17. Site: The places provided by the Procuring Entity where the Works are to be carried out, and other places stated in the Contract as forming part of the site.
18. Special Conditions of Contract: The conditions attached to the Contract Agreement, which shall govern the Contract and shall prevail over these General Conditions of Contract.
19. Specification: This Specifications including the Specification of the Works included in the Contract drawn up by the Procuring Entity setting out its requirements and/or objectives in respect of the provision of works, specifying, where relevant, the methods and resources to be used and/or results to be achieved.
20. Sub-Contractor: Any natural person, private or government entity, or a combination of the above, including its legal successors or permitted assigns who has a Contract with the Contractor to carry out a part of the Work in the Contract, which includes work on the Site.
21. Third Party: Any person or entity other than the Procuring Entity, the Contractor or a Sub-Contractor.
22. Works: All work associated with the construction, reconstruction, upgrading, demolition, repair, renovation of a building, road, or structure, as well as services incidental to works, if the value of those services does not exceed that of works themselves.

1.05 REFERENCE STANDARDS

A. Schedule of references:

AASHTO	American Association of State Highway and Transportation Officials.
ASTM	American Society for Testing and Materials.

ACI	American Concrete Institute.
ANSI	American National Standards Institute (USA).
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
BS	British Standards.
BSI	British Standards Institute (UK).
BS EN	British Standard European Norm.
EBSC	Ethiopian Building Standard Code.
EIA	Electronic Industries Alliance (USA).
ES	Ethiopian Standards.
ES ISO	Ethiopian Standards that are Identical in Content and Structure with ISO Standards.
ES IEC	Ethiopian Standards that are Identical in Content and Structure with IEC Standards.
IEC	International Electrotechnical Commission.
ISO	International Organization for Standardization.
NEC	National Electrical Code (USA).
NFPA	National Fire Protection Association (USA).
TIA	Telecommunications Industry Association (USA).
UL	Underwriter's Laboratories(USA).

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 014500

QUALITY CONTROL

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Other requirements pertaining to quality control are included in the General Conditions of Contract and in the various sections of the Specifications.

B. Regulatory Requirements: Section 014100.

1.02 COMPLIANCE

A. Comply with the requirements of applicable Referenced Standards and various Codes referenced in these Specifications.

1.03 REQUIREMENTS

A. Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation.

1.04 INSPECTION AND TESTING

A. Depending on the complexity of the work, the Contractor shall maintain adequate testing facilities at site.

B. Tests may, if approved, be carried out by recognized agencies, if site testing facilities are not required for the Works. The following requirements shall be maintained:
   1. Testing laboratory shall inspect materials and workmanship and perform tests described in this specification and additional tests requested by Resident Engineer. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of Resident Engineer to such failure.
   2. The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required in this Specification, within the agreed to schedule and/or time frame.

C. Where no testing requirements are specified, but become necessary, the Contractor shall set the testing done according to instruction. The cost of testing shall be borne as described in the costs section here under.

D. Tests shall be carried out in accordance with the procedures set out in the Standards and Codes, referred to in the Specification. In the absence of such procedures other approved procedures shall he used.

E. Cost: Costs associated with provision of materials for testing, testing costs, obtaining of records, etc., shall be borne by the Contractor, if such tests are required by the Specification or are deemed necessary (whether or not mentioned in the Specification) for

conformity of materials, workmanship and installed works to the requirements of the specification.

1. If tests are made for the convenience of Procuring Entity/Engineer such tests shall be carried out or cause to be carried out by the Contractor and related expenses shall be reimbursed by the Procuring Entity.

F. Written Reports:
   1. Testing laboratory shall submit test reports to Engineer's Representative, Contractor, unless other arrangements are agreed to in writing by the Resident Engineer. Submit reports of tests that fail to meet construction contract requirements on colored paper.

G. Verbal Reports: The Contractor and/or the Testing Laboratory shall give verbal notification to Engineer's Representative immediately of any irregularity.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 015000

TEMPORARY FACILITIES & CONTROLS

PART 1 GENERAL

1.01 DESCRIPTIONS

A. Temporary field office: Temporary field office to be utilized by Engineer and Engineer's Representatives and representatives of the Procuring Entity to coordinate and monitor daily construction activities performed by Contractor.

1.02 CONTRACTOR'S RESPONSIBILITY

A. Comply with applicable requirements specified in other sections of Specifications.

B. Provide temporary facilities and controls necessary for the Work, unless otherwise indicated.
   1. The temporary facilities and controls specified to be provided shall be kept operational by the Contractor for the Work.
   2. The temporary facilities and controls specified to be provided shall be installed as soon after award of the Contract as necessary to enable the Work of the Contract to proceed on schedule, and maintained until completion of the Work unless otherwise directed in writing.
      a. Maintain and operate temporary facilities and systems to assure continuous service.
      b. Modify and extend systems as the Work progress requires.
      c. Completely remove temporary materials and equipment when no longer required.
      d. Restore existing facilities used for temporary services to specified or original condition.

1.03 MEASUREMENT AND PAYMENT

A. Unless explicitly specified in the Contract Documents, no separate payment will be made for any temporary facilities and controls required under this section. Cost of such work is assumed to be distributed in the Contract prices.
   1. For any items of temporary facilities and controls specified in the Contract Documents, comply with the requirements for the specified items and provide the remaining unspecified items as per this specification.

1.04 TEMPORARY UTILITIES

A. Obtaining Temporary Service:
   1. Make arrangements with utility service companies for temporary services.
   2. Abide by rules and regulations of the utility service companies or authorities having jurisdiction.
   3. Be responsible for utility service costs until Date of Substantial Completion. Included are fuel, power, light, heat, and other utility services necessary for execution, completion, testing, and initial operation of work.

B. Contractor's camp:
   1. The Contractor, shall at approved locations, provide, erect, maintain and subsequently remove temporary living accommodation, offices, stores, workshop, sanitary facilities, compound fencing, lighting, etc., necessary for the completion of the works.

C. Temporary light and power:
   1. Provide electric power service required for the Work including required testing, lighting, operation of equipment, and other Contractor use.
   2. Electric power service includes temporary power or generators required to maintain plant operations during scheduled shutdowns.

D. Temporary Heat and Ventilation:
   1. Provide temporary heat necessary for protection or completion of the Work.

E. Telephone:
   1. Provide emergency telephone service at Project site for use by Contractor personnel and others performing work or furnishing services at the site.

F. Water:
   1. Provide water required for and in connection with work to be performed and for specified tests of piping, equipment, devices, or for other use as required for proper completion of the Work.
   2. Provide and maintain an adequate supply of potable water for domestic consumption by Contractor personnel, Engineer and Engineer's Representatives and representatives of the Procuring Entity.

1.05 CONSTRUCTION FACILITIES

A. Temporary field office:

   1. General:
      a. Locate office in vicinity of the Work at a location approved by Engineer or Engineer's Representatives or where indicated on Drawings.
      b. Furnish, Install and maintain field office for exclusive use of Engineer and Engineer's Representatives and representatives of the Procuring Entity. Provide sufficient room for Project meeting, Engineer's Representative and his staffs' office.
      c. Provide office within 10 days of Date of Commencement of the Work.
      d. Construct two all-weather, hard surfaced parking spaces for exclusive use of Engineer and Engineer's Representatives and representatives of the Procuring Entity. Provide all-weather surfaced walk between parking spaces and field office.
      e. Provide and maintain temporary electrical, sewer, and water service for duration of the Contract.

   2. Minimum Construction:
      a. Structurally sound foundation and superstructure.
      b. Weather tight with insulated roof, walls and ceiling.
      c. Resilient floor covering.

d. Screened windows with area equal to approximately 10 percent of floor area sufficient for light, view of the site, and ventilation. Provide each window with operable sash and burglar bars.
e. Secure exterior doors with dead-bolt cylinder locks and burglar bars.

3. Minimum Services:
   a. Exterior entrance light.
   b. Interior lighting.
   c. Electric power service.
   d. One telephone service.
   e. Sanitary facilities in field office with one water closet and one lavatory.

4. Minimum Furnishings:
   a. One 5-drawer desk.
   b. Two swivel desk chairs with casters.
   c. One plan table.
   d. One 4-drawer legal file cabinet complete with fifty legal-size hanging folders and two full-sized carriers.
   e. Two waste baskets.
   f. Protective helmets (hard hats) with ratchet adjustment.
   g. Conference table and chairs to accommodate 10 persons.

5. Provide adequate space for one set of Contract documents for ready reference.

6. Maintenance:
   a. Maintain all-weather surface driveway & parking areas, buildings, walkways, stairs and required furnishings and equipment for duration of the Contract.
   b. Provide janitorial services for duration of the Contract.
   c. Provide soap, paper towels, toilet paper, cleansers and other necessary consumables.
   d. Immediately repair damage, leaks or defective service.

B. First aid facilities:
   1. Provide a first aid kit throughout the construction period.
   2. The Contractor shall ensure that there is adequate arrangement to transport personnel to the nearest acceptable medical Centre in the event of injuries requiring medical attention beyond first aid.
   3. Have at least one person thoroughly trained in first aid.

C. Sanitary facilities:
   1. Provide and maintain sanitary facilities for persons on the site; comply with regulations of the Ethiopian Government.
      a. Provide toilet facilities for Contractor's and subcontractors' employees engaged on the Project. Locate toilets where directed and maintain them in a sanitary condition.
         1) The type and location of toilet shall be approved by the Engineer's Representative before construction.
         2) Keep toilets clean and supplied throughout the course of the Work.

D. Surveying Equipment and Assistance to the Engineer:
   1. The Contractor shall provide and maintain at all times surveying equipment, surveyors and assistants for the use of the Engineer and his representative. He shall

in addition provide sufficient tools such as pegs, poles, paint, strings, spirit level, and tools for checking the setting out of the works, etc., as required.

1.06 ROADS AND PARKING

A. Temporary road:
   1. Provide and maintain temporary roads for the use of all persons lawfully frequenting the site
   2. From the start of construction, provide and maintain adequate temporary roads which access all areas of the site requiring work under this and all related contracts. Provide a temporary road section sufficient to carry the heaviest construction traffic wheel loads resulting from this and all related contracts.
   3. Crown or slope the surface of temporary roads for adequate drainage. Provide temporary drainage, including swales, ditches, culverts and pumps as required, to maintain the temporary roads and prevent ponding water on the roads or on the site.

B. Parking:
   1. Park vehicles in areas where directed.
   2. Designate temporary parking areas to accommodate construction and Procuring Entity personnel. When site space is not adequate, provide additional off-site parking. Locate as approved by Engineer's Representative.
      a. Keep designated parking areas clear of dirt and debris resulting from the Work.

   3. Do not allow heavy vehicles or construction equipment in existing parking areas except approved by the Engineer's Representative.

C. Prevent interference with traffic and operations of the Procuring Entity on existing roads.

D. Minimize use by construction traffic on existing streets and driveways.

1.07 TEMPORARY BARRIERS AND ENCLOSURES

A. General: Provide barriers during performance of the Work to:
   1. Prevent unauthorized entry to work areas.
   2. Allow for Procuring Entity's occupancy of areas adjacent to the Site.
   3. Protect existing facilities and adjacent properties from damage.
   4. Protect vehicular and pedestrian traffic.

B. Temporary Dust Barriers:
   1. Provide temporary dust barriers to prevent the spread of dust from the work areas. Construct the dust barriers of wood framing sheathed with polyethylene film or other material approved by the Engineer's Representative. Secure the dust barriers in place without damaging existing construction.

C. Temporary closures for exterior wall openings:
   1. Whenever necessary, after the building is enclosed, to maintain proper temperatures for the performance of the Work, provide and maintain temporary closures for all openings in exterior walls that are not closed with permanent materials.
   2. During the period when plastering is being done and continuing thereafter until the plaster is properly cured, provide exterior window and door openings with temporary closures.

D. Scaffolding, Hoist, and Equipment Barriers:
   1. Provide temporary fence enclosures as required to prevent unauthorized persons from coming in contact with ground supported scaffolding, hoists, and equipment.

E. Temporary fence enclosure:
   1. Provide temporary fence and gate as directed.
   2. Maintain the temporary fence enclosure throughout the life of the Contract, or until directed to be removed. Replace all items or portions of fence enclosure damaged or destroyed.

F. Security:
   1. Protect the Work, materials, equipment, and property from loss, theft, damage, or vandalism. Protect Procuring Entity property used in performance of the Contract.
      a. Provide security guards as necessary as possible.

   2. Promptly relock doors and security screens located in access routes, storage areas, and work areas after use.
   3. Restore, by the end of each work day, existing in place safety/security items such as doors, screens, and alarm systems components that required removal, replacement, or adjustment to perform the Work, unless otherwise authorized in writing by the Engineer's Representative.

1.08 SAFETY REQUIREMENTS

A. Conform to the requirements of safety established by the Government.

1.09 PROTECTION OF WORK AND EXISTING PROPERTY

A. Protect installed Work and existing property during performance of the Work.

B. Maintain the building in a watertight condition during performance of the Work.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at wall projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, and movement of heavy objects by covering them with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed and roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Protect existing trees and plants during performance of the Work unless otherwise indicated. Box trees and plants within the grading limit lines. Do not deposit excavated materials or store building materials around trees or plants. Do not attach guy wires to trees.

H. Prohibit traffic from landscaped areas.

1.10 PROTECTION OF UTILITIES AND PIPELINES

A. Prevent damage to existing public utilities during construction. Approximate locations of known utilities may be shown on Drawings, but all lines may not be shown. Excavate with caution and repair lines damaged by construction operations.

B. If utility service lines are not shown on the construction document Drawings. Contractor should anticipate that such service lines exit and should exercise extreme caution during construction. The utility service lines should be repaired and restored immediately as per the specification, if damaged due to any construction activities. No separate payment will be made for this repair and restoration work. Include payment in unit price for work in appropriate sections.

1.11 PROTECTION OF UNDERGROUND FACILITIES

A. Known Underground Facilities may be shown on the Drawings but all Facilities may not be shown. Explore sufficiently ahead of trenching and excavation work to locate Underground Facilities in order to prevent damage to them and to prevent interruption of utility services. Restore damage to Underground Facilities to original condition at no additional cost to the Procuring Entity.

B. Avoid moving or changing public utility without prior written consent of a responsible official of the facility or structure. Allow representatives of utilities to enter the construction site for maintenance and repair purposes or to make necessary changes.

C. Assume risk for damages and expenses to Underground Facilities and Surface Structures within or adjacent to the Work

1.12 WATER CONTROLS

A. Provide & maintain pumping equipment necessary to keep the work area free from water. Discharge water into existing storm drainage systems or otherwise disperse as directed.

1.13 FIRE PREVENTION

A. Take precautions necessary to prevent fires.

B. Conform to specified fire protection and prevention requirements established by the Government.

C. Do not use flammable liquids, other than those specified, within a building without the written approval from the Engineer's Representative.

1.14 RUBBISH REMOVAL

A. The Contractor shall, during the construction period, maintain and clean up both permanent and temporary facilities. He shall provide temporary site drainage to leave the facilities free of standing water, accumulation of scrap, debris, waste material and maintain good standards of hygiene.

B. Inspection shall be carried out daily to ensure that sufficient workmen, tools and facilities are provided to maintain the standard of hygiene.

C. Final cleaning of the site and removal of all temporary facilities shall be carried out to approval at completion of works.

1.15 RELOCATION AND REMOVALS

A. Should a change in location of any construction facilities and temporary controls be necessary in order to progress the Work properly, remove and relocate such items as directed.

B. Remove the construction facilities and temporary controls when they are no longer required. Restore permanent facilities used for or connected to temporary facilities to their original condition or better.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

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SECTION 015800

PROJECT IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project identification sign description.

B. Project sign installation.

C. Maintenance and removal of Project sign.

1.02 SYSTEM DESCRIPTION

A. Sign Construction: Construct Project identification signs of new materials, for projects that meet any of the following criteria, in accordance with Standard Template Detail provided.
   1. For projects with a Contract Price of Birr 500,000 and above.
   2. For projects with smaller Contract Price; if the construction duration is longer than two months and the project is located in high traffic area.

B. Design requirements:
   1. The structural adequacy of the signboard inclusive of its supporting frame, supporting post, display surface and its fixings shall be justified with structural calculations.
   2. The signboard display surface and its fixing shall form part of the signboard structure.
   3. Supporting frames of the signboard shall be fixed to structural post in such a way that it will not impair the structural integrity or behavior of the supporting structural members. The fixing so provided should not overstress the signboard and should be able to safely sustain and transmit all loading including wind load acting upon the signboard.
   4. The supporting post to which the signboard is to be fixed should be structurally sound.
   5. The supporting frames of the signboard should be structurally tied to provide for adequate lateral stability.
   6. The display surface of the signboard shall be fixed to the supporting frame in such a way that it will not impair its structural integrity or behavior. The fixing so provided should not overstress both the display surface materials and the supporting frame. The fixings should be able to safely sustain and transmit all loading including wind load acting on the display surface.

C. Appearance: Maintain Project identification signs to present a clean and neat look throughout Contract duration.

D. Sign Manufacturer: Experienced professional company for the required Work.

E. Cost of Project Identification Sign: All cost of preparing, fixing, maintaining and other necessary works shall be covered by the contractor.

F. Sign Placement: At locations determined by the Engineer.
   1. Provide one sign for building construction Contracts.
   2. Provide one sign at each site for Contracts with multiple sites.
   3. Sign Relocation: As work progresses, relocate signs if directed by the Engineer in writing. Cost of the first relocation shall be covered by the contractor. Subsequent relocations, if directed by the Engineer in writing, will be subject to Variation Order.

1.03 SUBMITTALS

A. Shop drawing:
   1. Submit Shop Drawings under provisions of Section 013300 - Submittal procedures.

B. Show content, layout, lettering style, lettering size, and colors. Make sign and lettering to scale, clearly indicating condensed lettering, if used.

C. Structural plan and calculation: Submit the following for approval of the Engineer before the production of project identification sign:
   1. Layout of the signboard supporting frame and its fixings and supporting post.
   2. Typical connections and supporting fixing details, including details of fixing of the display surface to the signboard supporting frame and fixing of supporting post.
   3. Supporting calculations for structural works of the project identification sign in accordance with applicable Ethiopian Building Code of Standard.

1.04 QUALITY ASSURANCE

A. Sign painter: Professional experience in type of work required.

B. Finish, painting: Adequate to resist weathering and fading for the construction period.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Materials used for the construction of signboards shall be of such quality and grade that comply with applicable Standards.
   2. The supporting frame of the signboard should be made of non-combustible material.
   3. The display surface of the signboard and its fixings should be made of metal or any other materials that are non-combustible, waterproof and non-brittle.

B. Structure and Framing: Use new sign materials.
   1. Supporting frames:
      a. All structural metal used shall have a minimum yield strength and possess such chemical compositions and mechanical properties as specified in applicable Standards.
      b. All connections by welding shall be carried out by qualified welders. All welded connections and electrodes shall comply with applicable Standards.

   2. Sign Posts:
      a. Shall be metal or pressure treated wood type posts as determined by the Engineer.

b. Size: Shall comply with the minimum requirements obtained from the result of structural calculations. However the minimum cross-sectional size of posts shall not be less than10 cm by 10 cm.

3. Fasteners:
   a. Galvanized steel or other appropriate materials approved by the Engineer.
   b. Attach sign to posts by welding or with appropriate size and type of bolts and secure with nuts and washers.
   c. Paint fasteners to match sign background.

C. Sign (display surface): Shall be metal or plywood of appropriate type.
   1. Use 240 cm wide by 170 cm high sheet for the sign unless specified.
   2. Thickness: Shall comply with the minimum requirements obtained from the result of structural calculations.

D. Paints and Primers: Comply with applicable Standards.

E. Colors:
   1. Sign Background:
      a. Shall be dark blue unless different option is determined by the Engineer.

   2. Lettering on Blue Background:
      a. Shall be white for lettering on dark blue background unless different option is determined by the Engineer.

   3. Logos and Project Picture Background:
      a. Shall be white.

2.02 SIGN LAYOUT

A. Lettering:
   1. Style, Size, and Spacing:
      a. Calibri or Times New Roman font style.
      b. Letters with a minimum of 75 mm high for PROJECT NAME and 64 mm for others as measured by the upper case character.
      c. Use 40 mm vertical spacing between each information items.

   2. Condensed Style: Text may be condensed if needed to maintain sign composition.

B. Composition:
   1. Lines with Standard Text:
      a. Use lower left below the logo to list names for Procuring Entity, Contractor, Consultant, Project Location, etc., in their order as listed in Standard Template below.
      b. Center the last information item of ‘CONTACT ADDRESS FOR FURTHER INFORMATION’ as shown in Standard Template below.

2.03 LOGOS LAYOUT

A. Procuring Entity and Funders Logos:
   1. The Procuring Entity’s and other Funding organizations’ logos shall be displayed 10 cm from the top edge of the sigh display. The horizontal spacing between logos and

the ends of the display shall be divided equally. If there is one logo shall be at the middle on the space provided for logos.

2. A space of approximately 30 cm to 40 cm high shall be provided for the Procuring Entity and Funders Logos.
3. The Procuring Entity or the Engineer will provide the Logos to be affixed to the Project Identification sign.

2.03 PROJECT PICTURE LAYOUT

A. The Project Picture shall be displayed 10 cm from the right edge of the sign display and 10 cm from the bottom edge of the Logo.
   1. Size: 50 cm wide and 70 cm high.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install Project identification signs within seven days after Date of Commencement of the Work.

B. Erect signs at locations determined by the Engineer. Position sign so that it is fully visible and readable to general public.

C. Erect sign level and plumb.

D. Place posts 90 cm to 120 cm below grade and stabilize posts to minimize lateral motion.

E. Erect sign so that bottom edge of sign display is at a minimum height of 200 cm above existing grade.

3.02 MAINTENANCE AND REMOVAL

A. Keep signs and supports clean. Repair deterioration and damage.

B. Remove signs, framing, supports, and foundations to a depth of as required upon completion of Project. Restore area to a condition equal to or better than before construction.

3.03 PROJECT IDENTIFICATION SIGN TEMPLATE

A. The project identification sign display for information items and logos shall be prepared as per the Standard Template shown below.

B. Descriptions:
   1. Logos: Graphical symbol of the Procuring Entity and Funding Organizations.
   2. Procuring Entity: Name of the entity responsible for the project.
   3. Funding source: Name of the funding organization/Government.
   4. Contractor: Name of the Company that enters into the contract with the Procuring Entity for the construction of the Project.
   5. Consultant: Name of the Company that enters into the contract with the Procuring Entity for supervising and administering the Contract.

6. Project name: Name of the project stated in the contract.
7. Project location: Address of the project.
8. Project description: Summary of construction descriptions and main outputs that the project comprises.
9. Contract price: Contract price in Birr of the construction project.
10. Contract duration: Contract period in days, Commencement date and Completion date of the construction project.
11. Contact address for further information: Phone number of the Procuring Entity's Contact Person and website address to access further project information.

Project Identification Sign Display Standard Template.

PROCURING ENTITY'S AND FUNDERS' LOGOS

PROJECT NAME: _____

PROCURING ENTITY: _____

FUNDING SOURCE: _____

CONTRACTOR: _____

CONSULTANT: _____

PROJECT LOCATION: _____

PROJECT DESCRIPTION: _____

CONTRACT PRICE: _____

CONTRACT DURATION: _____

PROJECT PICTURE

Contact Address for Further Information: _____

END OF SECTION

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SECTION 016000

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Specific requirements pertaining to materials and equipment specified elsewhere are additional to the provisions of this Section.

1.02 PRODUCT LABELS

A. When materials or equipment are specified to conform to Referenced Standards or other reference specifications, the materials delivered to the site shall bear the manufacturer's printed labels stating that the materials meet the requirements of such referenced specifications.

1.03 MANUFACTURER'S INSTRUCTIONS

A. Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

B. Notify Engineer's Representative in writing, of conflicts between specifications and manufacturer's instructions, so that Engineer's Representative may establish course of action.

C. Improper installation or erection of products, due to failure in complying with these requirements, authorizes Engineer's Representative to require removal and re-installation at no increase in Contract Price or Contract Time.

1.04 QUALITY OF WORK

A. Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Engineer's Representative if required Work is such as to make it impractical to produce required results.

B. Do not employ anyone unskilled in their required duties. Engineer's Representative reserves right to require dismissal from site, workers deemed incompetent or careless.

C. Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Engineer, whose decision is final.

1.05 TRANSPORTATION AND HANDLING

A. Deliver factory packaged materials and equipment in the manufacturer's original containers.

B. Transport and handle materials and equipment in such a manner as to prevent their damage.

C. Arrange for delivery of materials and equipment during the hours of the day established by the Engineer's Representative.

D. Have workers available to receive and unload materials and equipment delivered to the site. Do not deliver, or have delivered, any materials and equipment to the site unless such forces are available.

1.06 STORAGE AND PROTECTION

A. Neatly pile, store, protect, and secure materials and equipment in locations where directed.

B. Protect materials and equipment subject to damage by temperature or other weather conditions.

C. Do not store volatile liquids in a Procuring Entity building.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 017000

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Other provisions pertaining to this Section are included of the Contract Documents.

B. Summary: Section 011000.

C. Submittal: Section 013300.

1.02 SUBMITTALS

A. Cutting or alteration submittals:
   1. Submit written request in advance of cutting or alteration which affects:
      a. Structural integrity of any element of Project.
      b. Integrity of weather-exposed or moisture-resistant elements.
      c. Efficiency, maintenance, or safety of any operational element.
      d. Visual qualities of sight-exposed elements.
      e. Work of Procuring Entity or separate contractor.

   2. Include in request:
      a. Identification of Project.
      b. Location and description of affected Work.
      c. Statement on necessity for cutting or alteration.
      d. Description of proposed Work, and products to be used.
      e. Alternatives to cutting and patching.
      f. Effect on Work of Procuring Entity or separate contractor.
      g. Written permission of affected separate contractor.
      h. Date and time work will be executed.

B. Surveying submittals:
   1. Submit name and address of Surveyor to Engineer's Representative.
   2. On request of Engineer's Representative, submit documentation to verify accuracy of field engineering work.
   3. Submit certificate signed by surveyor certifying & noting those elevations & locations of completed Work that do and don't conform to Contract Documents.

1.03 EXAMINATION AND PREPARATION

A. General: The examination and preparation part includes:
   1. Field engineering survey services to measure and stake site.
   2. Survey services to establish and confirm inverts for Work.
   3. Recording of subsurface conditions found.

B. Qualifications of surveyor:
   1. The surveyor shall be certified from recognized organization and have good knowledge and experience in the field.

2. Comply with the requirements of the Contract Documents or get approval from the Engineer before mobilizing to the site.

C. Survey reference points:
1. Existing base horizontal and vertical control points are designated on drawings.
2. Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
3. Make no changes or relocations without prior written notice to Engineer's Representative.
4. Report to Engineer's Representative when reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
5. Require surveyor to replace control points in accordance with original survey control.

D. Survey requirements:
1. Establish permanent bench marks on site, referenced to established bench marks by survey control points. Record locations, with horizontal and vertical data in Project Record Documents.
2. Establish lines and levels, locate and lay out, by instrumentation.
3. Stake for grading, fill placement.
4. Establish pipe invert elevations.
5. Stake batter boards for foundations.
6. Establish foundation column locations and floor elevations.
7. Establish lines and levels for mechanical and electrical work.

E. Existing services:
1. Where work involves breaking into or connecting to existing services, carry out work at times directed by authorities having jurisdiction, with minimum of disturbance to pedestrian and vehicular traffic.
2. Before commencing work, establish location and extent of service lines in area of Work and notify Engineer's Representative of findings.
3. Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Engineer's Representative.

F. Location of equipment and fixtures:
1. Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
2. Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
3. Inform Engineer's Representative of impending installation and obtain approval for actual location.
4. Submit field drawings to indicate relative position of various services and equipment when required by Engineer's Representative.

G. Records:
1. Maintain a complete, accurate log of control and survey work as it progresses.
2. Record locations of maintained, re-routed and abandoned service lines.

H. Subsurface conditions:

1. Promptly notify Engineer in writing if subsurface conditions at Place of Work differ materially from those indicated in Contract Documents, or a reasonable assumption of probable conditions based thereon.
2. After prompt investigation, should Engineer's Representative determine that conditions do differ materially, instructions will be issued for changes in Work.

1.04 EXECUTION

A. Cutting and patching the Work:
   1. Preparation:
      a. Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
      b. After uncovering, inspect conditions affecting performance of Work.
      c. Beginning of cutting or patching means acceptance of existing conditions.
      d. Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
      e. Provide protection from elements for areas which may be exposed by uncovering work; maintain excavations free of water.
      f. Obtain Engineer's Representative's approval before cutting, boring or sleeving load-bearing members.

   2. Execution:
      a. Execute cutting, fitting, and patching including excavation & fill to complete Work.
      b. Fit several parts together, to integrate with other Work.
      c. Uncover Work to install ill-timed Work.
      d. Remove and replace defective and non-conforming Work.
      e. Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
      f. Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
      g. Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
      h. Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
      i. Restore work with new products in accordance with the Contract Documents.
      j. Fit Work to pipes, sleeves, ducts, conduit, & other penetration through surfaces.
      k. At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with fire-stopping material in accordance with the requirements.
      l. Refinish surfaces to match adjacent finishes: For continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.
      m. Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.
      n. Make cuts with clean, true, smooth edges.
      o. Where new work connects with existing, and where existing work is altered, cut, patch and make good to match existing work.

1.05 CLEANING

A. General:
   1. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.

2. Store volatile waste in covered metal containers and remove from premises at end of each working day.
3. Provide adequate ventilation during use of volatile or noxious substances. Use for building ventilation systems is not permitted for this purpose.
4. Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

B. Project cleanness:
1. Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Procuring Entity or other Contractors.
2. Remove waste materials and debris from site at the end of each working day. Do not burn waste materials on site.
3. Provide on-site containers for collection of waste materials and debris.
4. Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.
5. Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
6. Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

C. Final cleaning:
1. When Work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
2. Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
3. When the Work is Totally Performed, remove surplus products, tools, construction machinery and equipment. Remove waste products and debris other than that caused by the Procuring Entity or other Contractors.
4. Remove waste materials from the site at regularly scheduled times or dispose of as directed by the Engineer's Representative. Do not burn waste materials on site.
5. Leave the work broom clean before the inspection process commences.
6. Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
7. Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, floors and ceilings.
8. Clean lighting reflectors, lenses, and other lighting surfaces.
9. Vacuum clean and dust building interiors, behind grilles, louvers and screens.
10. Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
11. Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
12. Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
13. Remove dirt and other disfiguration from exterior surfaces.
14. Clean and sweep roofs.
15. Sweep and wash clean paved areas.
16. Clean equipment and fixtures to a sanitary condition; clean or replace filters of mechanical equipment.

1.06 CONTRACT CLOSEOUT PROCEDURES

A. Final inspection and declaration procedures:

1. Contractor's Inspection: The Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects; repair as required. Notify the Engineer's Representative in writing of satisfactory completion of the Contractor's Inspection and that corrections have been made. Request Engineer's Representative's detail Inspection.
2. Engineer's Representative's Inspection: Engineer's Representative and the Contractor will perform an inspection of the Work to identify obvious defects or deficiencies. The contractor shall correct Work accordingly.
3. Completion: Submit written certificate that the following have been performed:
   a. Work has been completed and inspected for compliance with Contract Documents.
   b. Defects have been corrected and deficiencies have been completed.
   c. Equipment and systems have been tested, adjusted and balanced and are fully operational.
   d. Certificates required by Fire Commissioner, Utility companies have been submitted.
   e. Operation of systems have been demonstrated to Procuring Entity's personnel.
   f. Work is complete and ready for Final Inspection.

4. Final Inspection: When items noted above are completed, request final inspection of Work to the Engineer's Representative. If Work is deemed incomplete by the Engineer's Representative, complete outstanding items and request a re-inspection.
5. Declaration of Substantial Performance: When the Engineer's Representative considers deficiencies and defects have been corrected and it appears requirements of Contract have been substantially performed, make application for Certificate of Substantial Performance. Refer to General Conditions of Contract for specifics to application.
6. Commencement of Warranty Periods: The date of acceptance of the submitted declaration of Substantial Performance shall be the date for commencement for the warranty period.
7. Declaration of Total Performance: When the Engineer's Representative considers final deficiencies and defects have been corrected and it appears requirements of the Contract have been totally performed, make application for certificate of Total Performance. Refer to General Conditions of Contract for specifics to application. If Work is deemed incomplete by the Consultant, complete the outstanding items and request a re-inspection.

B. Re-inspection:
   1. Should status of work require re-inspection by Engineer's Representative due to failure of work to comply with Contractor's claims for inspection, Procuring Entity will deduct amount of compensation for re-inspection services from payment to Contractor, unless specified otherwise.

1.07 PROJECT RECORD DOCUMENTS

A. Maintain on site, 2 sets of the following record documents; record actual revisions to the Work:
   1. Contract Drawings.
   2. Product installed.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.

B. Store record documents separate from documents used for construction.

C. Record information concurrent with construction progress.

D. Legibly mark and record a description of the actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by addenda and modifications.

E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish (first) (main) floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract Drawings.

F. Upon completion of the work, create electronic versions of the project record documents. Black and white as well as colored documents are to be scanned.
   1. The scanned images are to be put on a compact disc (CD). Name the electronic files with the same name as the drawing. Create a folder on the CD for each trade and one for Shop Drawings.
   2. Label the CD with the project number, name, and title as it appears on the project manual cover.

G. Applications for progress payments will not be approved if the record documents are not kept current. Application for final payment will not be approved until the project record documents are delivered to the Engineer's Representative.

1.08 OPERATION AND MAINTENANCE DATA

A. Prepare 2 sets of operation and maintenance data. Prepare a printed Table of Contents for each volume, with each product or system description identified. Internally subdivide the binder contents with permanent page dividers, logically organized as described below, with tab titles clearly printed under reinforced laminated plastic tabs:

   Part 1: Listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, subcontractors, and major equipment suppliers.

   Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of subcontractors and suppliers. Identify the following:
   1. Significant design criteria.
   2. List of equipment.
   3. Parts list for each component.
   4. Operating instructions.
   5. Maintenance instructions for equipment and systems.

6. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.

Part 3: Project documents and certificates, including the following:
1. Shop drawings and product data.
2. Air and water balance reports.
3. Certificates.
4. Photocopies of warranties.

B. Submit one copy of completed volumes in final form 15 days prior to final inspection. This copy will be returned after final inspection, with the Engineer's comments. Revise content of documents as required prior to final submittal.

C. Submit 2 volumes prior to final Application for Payment.

1.09 WARRANTIES

A. Furnish warranty certification and copies of warranties that extend beyond the one year period required by the General Conditions of Contract and this Specifications. Warranties submitted without warranty certification will not be accepted.
   1. Warranty Certification: Written certification from the warrantor that invoices for installation, service, supplies, and warranty fees have been paid in full to persons or firms due payment, and that the warranty is in effect and non-retractable due to any of the specified conditions.

B. Prepare printed Table of Contents and assemble warranty certifications and warranty copies in a binder with a durable plastic cover.

C. Deliver the binder to the Engineer's Representative prior to final Application for Payment.

D. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, indicating date of acceptance as start of warranty period.

E. Applications for final payment will not be approved until the warranty certification and warranty documents are delivered to the Engineer's Representative.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

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DIVISION 02 – EXISTING CONDITIONS

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SECTION 024100

DEMOLITION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Temporary Facilities and Controls: Section 015000.

B. Execution and Closeout Requirements: Section 017000.

C. Earthwork: Section 310000.

1.02 REFERENCES

A. ES 1556: Code of Practice for Demolition.

B. EBSC – 14: Health and Safety Code of buildings.

C. ES EN 143: Respiratory Protective Devices – Particle Filter – Requirements, Testing, Marking.

D. ES EN 166: Personal Eye Protection – Specifications.

E. ES ISO 3873: Industrial Safety Helmets.

F. ES ISO 20345: Personal Protective Equipment – Safety Footwear.

1.03 SUBMITTALS

A. Quality Control Submittals:
   1. Permits: Submit one copy of each permit.
   2. Demolition Plan: Submit one copy of the demolition plan required under Quality Assurance Article.

1.04 QUALITY ASSURANCE

A. Regulatory requirements:
   1. Permits: Before the Work of this Section is started obtain all permits required by concerned Governmental body and/or Local Authority for all phases and operations of the Work.
   2. Health and Safety: All protective precautions shall be maintained during demolition Work by complying with the requirements of EBSC – 14 and other applicable Referenced Standards.

B. Demolition Plan: Before the Work of this Section is started, prepare a detailed demolition plan. The demolition plan shall include, but not be limited to, detailed outline of intended demolition and disposal procedures. The demolition plan will not relieve the Contractor of complete responsibility for the successful performance of the Work in accordance with all applicable codes and restrictions.

1.05 PROJECT CONDITIONS

A. Existing Paint: Precautions shall be taken as required to prevent spread of dust on painted areas.

B. Recycle demolition debris to the extent possible.

C. Burning is prohibited unless specified otherwise.

D. The use of explosives is prohibited unless specified otherwise.

E. The restricted areas or roads for demolition related equipment shall not be accessed unless otherwise approved in writing by the Procuring Entity or Engineer.

F. All known asbestos containing materials be removed before a demolition shall be checked.

G. Protect utilities during the Work of this Section.

H. Verify the location and status of all utilities as required by the Contract Documents.

I. Identify utilities that will be disconnected by others.

J. Prior to beginning demolition, verify that all utilities serving the building to be demolished have been disconnected.

K. Do not interrupt utility services to buildings which are to remain unless obtained permission from Procuring Entity or Engineer's Representative.

L. Employ watchpersons, as required and considering the extent of demolition, to patrol the site 24 hours per day, 7 days a week, from the time demolition is started until rough grading is completed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Any material required for the demolition Works shall be in accordance with the requirements of the Contract Documents and/or applicable Referenced Standards, or in the absence of such requirements/Standards, they should be the best of their respective kinds for the Work required.
   1. Selected Fill: As specified in Earthwork Section. Combustible materials, metal, glass, or other debris are not acceptable.

B. Materials arising from the Works should be removed as they accrue and not stored, disposed of or used again on the site, except with the approval of the Procuring Entity.

C. Any timber infected with lice, bugs, dry rot, woodworm, or death watch beetle, or that is otherwise decayed, should be disposed of by burning on the site, wherever possible, and Statutory or Local Authority requirements permit; otherwise such timber should be

removed by the demolition Contractor and burnt on a site to be indicated or provided by him.

PART 3 EXECUTION

3.01 GENERAL

A. Unless specified otherwise, all the execution of demolition shall comply with the requirements of ES 1556.

3.02 SITE VERIFICATION

A. Survey:
   1. General: Before any works of demolition are started, a detail survey and examination of the building or structure and its curtilage should be made, and recorded and kept available for inspection. Photographs should be taken when necessary. Special care should be taken when entering and surveying buildings affected by fire or blast damage.
   2. All available plans of the building or buildings shall be examined.
   3. The relationship and condition of the adjoining property and other properties that may be affected by the demolition should also be considered.
   4. The possible effect of ground structural tremors caused by falling rubble may need to be considered when work is carried out in the vicinity of hospitals and other buildings containing equipment sensitive to shock and vibration. The possible modifying effects of local ground structure and geological strata on the dispersion of such tremors should also be borne in mind.
   5. During the survey, particular attention should be given to the nature of the construction of the building or structure. Also the building or structure should be examined and, if necessary, tests be carried out, to determine its condition whether constituent materials have deteriorated in strength, which could result in instability arising during particular demolition process.

3.03 PREPARATION

A. Protection of site personnel: Comply with the requirements of EBSC – 14 and the followings.
   1. The requirements for protective precautions stated in ES 1556.
   2. The requirements for respiratory protective devices of ES EN 143.
   3. The requirements for eye protection of ES EN 166.
   4. The requirements for safety helmets of ES ISO 3873.
   5. The requirements for safety footwear of ES ISO 20345.
   6. In additional to the above requirements, comply also applicable Standards of Ethiopian Standard Agency required by Demolition Works.

B. Precautions against uncontrolled collapse:
   1. If the structure, during demolition, abuts other buildings, the abutting buildings should be given lateral support or shoring complying with ES 1556.

C. Provide temporary chain link fence of appropriate height or as specified in the Contract Documents, including all required gates, around the building prior to start of the Work of

this Section. Locate temporary fence where directed. Remove temporary fence in its entirety, including all anchorage materials, after completion of backfill operations.

D. Search each building. Locate drums or containers of hazardous wastes. Remove hazardous wastes in accordance with the requirements of EBSC – 14.

E. Remove loose equipment, materials, supplies, and furnishings (desks, chairs, beds, mattresses, furniture, etc.) from building prior to demolition.

F. Remove items scheduled to be salvaged for the Facility, and place in designated storage area.

G. Pump out standing water from basement and crawl space areas of the building prior to demolition. Remove all mechanical equipment, piping, etc. from basement areas prior to demolition.

H. Pump out cesspools, septic tanks, and fuel tanks and remove contents as required.

3.04 DEMOLITION

A. General: Perform demolition by hand or mechanical method as required. Bursting (explosive) method of demolition may be performed if and only if it is expressly specified in the Contract Documents. Comply with the requirements stated in ES 1556 for method of demolition in use, and the appropriate precautionary measures that should be taken on site.

B. Perform demolition in a systematic manner, beginning at the top of the structure and proceeding to lowest basement floor. Complete demolition above each floor level before disturbing supporting members on lower levels.

C. Wet down masonry and plaster materials during demolition to prevent spread of dust and dirt. Sprinkle debris, and use temporary enclosures as necessary to limit dust to lowest practicable level. Do not use water to extent causing flooding, contaminated runoff, or icing.

D. Do not place demolition equipment in buildings where it will create excessive loads on supporting walls, floors, and frames. Promptly remove accumulated debris and materials.

E. Lower structural framing members to ground by hoist or crane as required.

F. Remove below grade combustible material, glass and metal as required.

G. Remove walks, roads, pavements, curbs, slabs on grade, and fences within Contract requirements, unless shown or directed otherwise.

3.05 DISPOSAL

A. Transport demolition debris and excess fill to designated disposal area as soon as practicable. If necessary, grade disposal areas to adjacent contours and slope to drain.

B. Unless specified otherwise, do not store, sell, or burn materials on the construction site.

3.06 BACKFILLING AND GRADING

A. Place fill in basements and other voids as per the requirements in the Contract Documents. Where broken concrete and masonry materials are used for backfill, place fill in layers not exceeding 20cm depth and compact each layer. Broken concrete and masonry shall not be used as fill material outside the limits defined by the original building foundation walls.

B. Final 20cm depth of backfill below topsoil elevations shall be selected fill.

C. Rough grade surface to adjacent contours and slope to drain as required.

3.07 SALVAGE SCHEDULE

A. The list of items to be retained ownership by the Procuring Entity shall be identified. Prior to demolition, remove, prepare and place the items indicated where directed.

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DIVISION 03 – CONCRETE

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Ministry of Construction

SECTION 031100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Steel Concrete Reinforcement: Section 032100.

B. Cast-In-Place Concrete: Section 033000.

1.02 REFERENCES

Except as shown or specified otherwise, the Work of this Section shall conform to the requirements of Standards listed below:

A. EBSC – 2 (EBSC EN 1992-1-1:2015): Ethiopian Building Code of Standard, Structural Use of Concrete.

B. EBSC – 3: Ethiopian Building Code of Standards, Design of Steel Structures.

C. EBSC – 5: Ethiopian Building Code of Standards, Utilization of Timber.

D. ES 2023: Concrete Surface and Formwork Surface.

E. ES 3093: Code of Practice for False-work.

F. BS 1139: Metal Scaffolding. Section 1.1: Specification for Steel Tube.

G. BS 2482: Specification for Timber Scaffold Boards.

H. BS 6100: Section 6.5: Glossary of Building and Civil Engineering Terms. Part 6. Concrete and Plaster: Section 6.5: Formwork.

1.03 DEFINITIONS

A. Unless specified otherwise, the terms in this section shall comply with the definition stated in BS 6100: Section 6.5 and the following:
   1. Formwork: Structure, either temporary or permanent, provided to contain fresh concrete and support it in the required shape and size until it has hardened.
   2. Formwork Panel: Prefabricated framed sheeting intended for repeated use.
   3. Scaffold: A temporary provided structure that provides access, or on or from which persons work, or that is used to support material, plant or equipment.
   4. Falsework: Any temporary structure used to support a permanent structure while it is not self-supporting.

1.04 DESIGN REQUIREMENTS

A. The Contractor shall be responsible for the design, stability, easing and striking of all formwork and falsework.

B. Formwork and falsework shall be designed so that they are capable of resisting all actions which may occur during the construction process. They shall remain undisturbed until the concrete has achieved sufficient strength to withstand the stresses to which it will be subjected on stripping or release, with an acceptable margin of safety.
   1. They shall be designed to include own weight, live load, weight of moving equipment operated on formwork, weight of the concrete in its fluid condition, ambient temperature, and other factors pertinent to safety of structure during construction.

C. Formwork and falsework shall be sufficiently strong and so placed and secured to ensure absolute rigidity during pouring, tamping, vibrating and compacting of concrete without showing appreciable deflection and loss of liquid.

D. Vertical and lateral loads shall be carried to the ground by formwork and falsework and in place construction that has attained adequate strength for the purpose until such loads can be supported by the concrete structure.

E. Formwork and falsework shall be so designed that the finished concrete shall conform to the dimensions and contours shown on drawings.

F. Design Calculations and Drawings: Formwork and falsework shall be designed by a professional engineer licensed and based on the requirements of applicable Ethiopian Standard. The engineer's calculations and drawings shall be signed and sealed by the engineer and kept on the job. Formwork and falsework shall be constructed in accordance with the engineer's signed and sealed drawings.

1.05 SUBMITTALS

A. Prior to construction of formwork and falsework, the Contractor shall submit for approval details of materials, proposed construction methods and formwork and falsework design calculations.

B. Shop Drawings: The Contractor shall submit shop drawings for formwork and falsework to the Engineer before proceeding construction.

1.06 QUALITY ASSURANCE

A. No concrete shall be poured until the formwork and falsework has been inspected and approved, and instruction to proceed with pouring of concrete is given by the Engineer in writing.

B. Qualifications of workmen: At least one personnel involved for the construction of concrete formwork shall be of good experience in the field and have applicable certificate from the recognized organization.

C. Mock-up:
   1. Mock-up is used only if required by the architect or/and specified on the Contract Documents.
   2. Provide formwork for mock-up of cast-in-place concrete.
   3. Construct forms using facing materials required to provide specified finishes and textures.

4. Do not proceed with structure formwork until sample panels and forms have been approved by the Engineer/Architect in writing.

1.07 DELIVERY, STORAGE AND HANDLING

B. The storage and handling of timbers shall comply with the requirements of applicable Referenced Standards.

C. Formwork materials shall be delivered to the site immediately after taking over the site. Formwork timber and panels shall be stacked in off ground position. Timber for formwork shall be stored under shed.

D. Timber and panel formwork for re-use shall be cleaned, oiled and stacked.

PART 2 PRODUCTS

2.01 MATERIALS

A. Scaffold:
   1. Steel tube: Shall comply with the requirements stated in BS 1139.
   2. Steelwork other than tube: Comply with ES 3093.
   3. Timber: Comply with EBSC – 5.

B. Formwork panel:
   1. Timber panel: Comply with EBSC – 5.
      a. Formwork surface shall comply with the requirements of ES 2023.
      b. Material shall be sawn board reasonably straight grained plywood be use of which shall be determined in compliance with the type of surface finish.

C. Form coating compounds shall be of approved quality and those that do not stain, bond or adversely affect the concrete or its curing.

PART 3 EXECUTION

3.01 PREPARATION OF FORM SURFACES

A. Rubbish, particularly wire cut-off, chipping, shaving and sawdust, shall be removed from the interior of the forms before concrete is poured.
   1. Washout holes shall be provided to facilitate cleaning.
   2. Formwork surfaces in contact with concrete shall be cleaned and thoroughly wetted and treated with an approved none staining mould oil or other composition.
   3. Approved mould oil or composition shall be kept out of contact with the reinforcement and shall be used as sparingly as possible

B. Apply form-coating material in accordance with manufacturer’s instructions.

3.02 INSTALLATION

A. Forms shall be constructed to the exact shapes and dimensions shown and as required to obtain accurate alignment, location grade, level and plumb work in finished structures.

Provision shall be made for openings, offsets, sinking, recesses, moldings, reglets, chamfers, screeds, anchorages, inserts and other required features.

B. Forms shall be fitted in successive units for continuous surface to accurate alignment, free from irregularities and within allowable tolerances.

C. Forms for openings and construction which accommodate installation by other trades whose materials and products are fabricated before measurements could be taken shall be accurately dimensioned and located as shown on drawings. Where deviation from the drawing dimensions results in problems on site, the Contractor shall be responsible for the rectification of the problems as approved.

D. Forms shall be fabricated for easy removal without hammering or prying against concrete surfaces. Crush or wrecking plates shall be provided where stripping may damage cast concrete surfaces. Additional forms shall he provided as required for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Curf wood inserts for forming reglets, recesses, and the like shall be provided to prevent swelling and assure ease of removal.

E. Temporary openings shall be provided where interior area of formwork is inaccessible for cleaning and where pouring of concrete exceeds 1.3m in height. They shall be placed in inconspicuous locations as much as possible and consistent with design requirements.

F. Shores and struts shall be provided with positive means of adjustment using wedges, jacks or other appropriate means, capable of taking up formwork settlement during concrete placing operations. Truss supports shall be used where adequate foundation for shores and struts cannot be secured.

G. Form facing materials shall be supported by structural members spaced sufficiently close to prevent undesirable deflection.

H. Cambers in formwork shall be provided as required for anticipated deflections due to weight and pressure of fresh concrete and construction loads.

I. Formwork spacers left in the concrete should not impair its durability or appearance.

3.03 REMOVAL OF FORMWORK AND FALSEWORK

A. Formwork and falsework shall not be removed until the concrete is sufficiently strong to carry the loads for which it is designed. The responsibility for the safety of the concrete will rest entirely with the Contractor and he will be held liable for any damage resulting from formwork failure.

B. The removal of formwork and falsework shall be done without shock or vibration. The time between casting and removal of formwork depends mainly on the strength development of concrete and on the function of the formwork. The minimum timing of removal of formwork and supports shall be in accordance with the provisions of applicable Referenced Standard. Centering and shuttering to beams shall not be removed until the concrete has been in place for not less than 28 days.

C. Formwork and shuttering shall generally be removed from the bottom upwards, and in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

3.04 FORMWORK CLASSIFICATION

A. Ordinary Finish Formwork:
   1. Formwork material for concrete concealed from view or to be finished with covering materials shall be sawn board, plywood or steel panel reasonably straight grained to provide mechanical bond for subsequent application of finish.
   2. After removal of formwork, the face of the exposed concrete shall be rubbed down immediately to remove fins or other irregularities. In the event of parts of the concrete being honeycombed, such portions shall be cut out to required depth and shape and made up with concrete of approved quality. The face of the concrete for which formwork is not provided, other than those against which backfill or further concrete or other material is to be placed shall be floated smooth to give a finish equal to that of the rubbed down face where formwork is provided.
   3. Face of concrete intended to be plastered or rendered shall be hacked or treated with a bonding agent to form satisfactory adhesion.

B. Fair Face Concrete Formwork:
   1. Formwork for exposed concrete surface to be finished fair face shall be plywood, metal or other panel material to provide continuous, straight, and smooth as cast surfaces. Panel sizes shall be as large as practicable to minimize joints.
   2. Where directed, faces of concrete shall be finished fair by means of wart formwork, to produce a true surface and shall have all imperfections in the concrete face cut out and made good in cement mortar to match the texture and color of the concrete. The concrete shall be rubbed down with carborundum stone, dipped in cement grout to finish clean and smooth to a high standard, without trace of shuttering marks, joints or other disfigurements.

C. Patterned Concrete Formwork:
   1. Formwork for patterned concrete surface shall be for fair face finish in plywood, milled timber board, metal or other panel material to provide straight, smooth as cast surfaces as specified or directed.
   2. Patterned finish shall be formed with approved wart boards of specified nominal width, having exposed grain and being arranged as shown on drawings.
   3. Timber boards where specified, shall be tongued and grooved and of adequate thickness. The edges of boards shall have a nominal 2mm chamfer to form controlled fins.
   4. The resulting concrete shall clearly show grain. Individual board marks shall be free from honeycombs and excessive air holes and shall be of uniform color.

3.05 RE-USE OF FORMS

A. Split, frayed, delaminated or otherwise damaged form facing material shall not be used.

END OF SECTION

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SECTION 032100

STEEL CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Formwork: Section 031100.

B. Cast-In-Place Concrete: Section 033000.

1.02 REFERENCES

A. EBSC – 2 (EBSC EN 1992-1-1:2015): Ethiopian Building Code of Standard, Structural Use of Concrete,

B. ES ISO 6934-3: Steel for the Pre-stressing of Concrete. Part 3: – Quenched and Tempered Wire.

C. ES ISO 6934-4: Steel for the Pre-stressing of Concrete. Part 4: – Strand.

D. ES ISO 6934-5: Steel for the Pre-stressing of Concrete. Part 5: – Hot Rolled Steel Bars with at Subsequent Processing.

E. ES ISO 10544: Cold Reduced Steel Wire for the Reinforcement of Concrete and the Manufacture of Welded Fabrics.

F. ES ISO 10144: Certification Scheme for Steel Bars and Wires for the Reinforcement of Concrete Structure.

G. ES ISO 6935-3: Steel for the Reinforcement of Concrete— Part 3: Welded Fabric.

H. ES IS0 6934-1: Steel for the Pre-stressing of Concrete. Part 1 – General Requirement.

I. ES ISO 69342: Steel for the Pre-stressing of Concrete. Part 2 – Cold Drawn Wire.

J. BS 4449: Specification for Carbon Steel Bars for the Reinforcement of Concrete.

1.03 SUBMITTALS

A. Shop Drawings: Placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports.

B. Quality Control Submittals:
   1. Certificates: Confirmation required under Quality Assurance Article.

1.04 QUALITY ASSURANCE

A. Certifications:
   1. Generally the certification scheme for steel bars and wires for the reinforcement of

concrete structure shall comply with ES ISO 10144.

2. The Contractor shall submit for approval, the manufacturer's certificate of test showing the following characteristics for reinforcing bars and wires prior to placing order. However, independent tests may be ordered to be made and any steel which does not comply in all respects with the required properties shall be rejected.
   a. Ultimate tensile stress
   b. Yield point stress
   c. Elongation
   d. Cold bend test

B. Where certified test data is not issued, tests shall be made to verify the above properties. The criteria for the acceptance of the above test results shall be those required by the Referenced Standards.

C. Where deformed and/or twisted bars are specified, the form of the bars used must be approved and shall be such as to provide a net section at all points equivalent to that of a plain bar of equal nominal.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Reinforcement shall be delivered in sufficient quantities prior to start of concrete work, to ensure that no constructed formwork lies idle and exposed to weather due to reinforcement not being placed in position.

B. Reinforcement shall be stored in off-the-ground position to prevent rust by contact with soil, dampness and other objectionable material.

C. Prevent bending, coating with earth, oil or other material, or otherwise damaging the reinforcement.

D. Shall comply with the requirements of applicable Referenced Standards.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing bar: Unless indicated in the Contract Documents, reinforcement shall be deformed bars, except spirals, and welded wire reinforcement, which may be plain. Reinforcement shall be the grades, types, and sizes required by Contract Documents and shall conform to the following:
   1. The characteristic strength, physical, mechanical and technological property, classification and geometry of reinforcing steel shall comply with the requirements stated in EBSC – 2.
   2. Hot rolled steel bars for the pre-stressing of concrete shall conform to ES ISO 6934-1.
   3. Welded fabric reinforcement for concrete shall conform to ES ISO 6935-3.
   4. Carbon steel bars for the reinforcement of concrete shall conform to BS 4449.

B. Wire: Use plain or deformed wire as indicated on Contract Documents. Plain wire may be used for spirals.

1. Quenched and tempered wire for the pre-stressing of concrete shall conform to ES ISO 6934-3.
2. Cold drawn wire for the pre-stressing of concrete shall conform to ES ISO 69342.
3. Cold reduced steel wire for the reinforcement of concrete for the size of 4mm to 12mm in diameter shall conform to ES ISO 10544.

C. Strand for the pre-stressing of concrete:
4. It shall conform to ES ISO 6934-4.

PART 3 EXECUTION

3.01 PREPARATION

A. Formwork and conditions under which reinforcement is to be placed shall be examined and corrected prior to the placement of reinforcement. Such cleaning up and correction shall be as described in the concrete & formwork Sections of this Specification.

3.02 FABRICATION

A. Shall comply with the requirements of EBSC – 2 and applicable Referenced Standards.

B. Reinforcement: Bend reinforcement cold unless heating is permitted. All reinforcement shall be to the forms and dimensions as shown on Drawings or approved shop submittal. Bars are to be bent and straightened in such a manner as to avoid any injury to the metal. Bars having cracks or splits at the bends shall be rejected.
1. Bending of reinforcement bars at a temperature below 5^0C shall not be permitted.

3.03 PLACING

A. All reinforcement shall be placed and maintained exactly in the position shown on Drawings or approved shop submittal. Bars connected longitudinally shall be overlapped exactly as shown on the drawing or approved shop submittal and having an overlap length as specified or at least forty times the diameter of the bar and are to be securely wired. Bars shall be firmly bound together at intersections with 1.6mm mild steel wire. Bars shall be hooked in the manner shown on Standard Drawings.

B. Reinforcement shall be free from dirt, grease, oil, paint, scale and rust when placed in position. Any reinforcement left to stand before concreting shall, if required, be pretreated with cement-water wash.

C. To ensure that the required concrete cover shown on the drawings is maintained at all points, precast concrete cubes, or metal packing in pieces of appropriate thickness shall be used wherever necessary.

D. The placing and binding of reinforcement, in each section of the work, shall be approved by the Engineer's representative before any concrete is placed in the section concerned

E. Bar Reinforcement: In rectangular panels of two-way construction, place the steel in the short direction first with the longer bars on top in the opposite direction.

F. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise shown.

END OF SECTION

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: Section 310000.

B. Concrete Walks: Section 321300.

C. Concrete Formwork: Section 031100.

D. Steel Concrete Reinforcement: Section 032100.

1.02 REFERENCES

Except as shown or specified otherwise, the Work of this section shall conform to the requirements of Standards listed below:

A. EBSC – 2 (EBSC EN 1992-1-1:2015): Ethiopian Building Code of Standard, Structural Use of Concrete,

B. ES 3137: Structural Use of Concrete - part 1: Code of Practice for Design and Construction,

C. ES 3281: Execution of Concrete Structures - part 1: Common,

D. ES 1682: Code of Practice for Cleaning and Surface Repair of Buildings. Cleaning of Natural Stones, Brick, Terracotta and Concrete

E. ES 2341: Aggregates for Concrete,

F. ES 2261: Specifications for Building Sands from Natural Sources,

G. ES 2367: Specification for Aggregates from Natural Sources for Concrete,

H. ES 2275: Aggregates - Part 4: Lightweight Aggregates for Concrete, Mortar and Grout-Guidance on the use of BS EN 13055-1,

I. ES 2169: Specification for Low Heat Portland Cement,

J. ES 2171: Specification for Sulfate - Resisting Portland Cement,

K. ES 2179: Specification for Pozzolanic Pulverized-fuel Ash Cement,

L. ES 1177-2: Cement Part 2: Conformity Evaluation,

M. ES 2023: Concrete Surface and Formwork Surface,

N. ES 1649: Workmanship on Building Sites. Code of Practice for Concrete Work. Mixing and Transporting Concrete,

O. ES 2309: Admixtures for Concrete, Mortar and Grout. Part 2: Concrete Admixtures. Definitions. Requirements, Conformity, Marking and Labeling,

P. ES 3735-42: Steel-Filled Epoxy Resin Based Adhesive – Specification,

Q. ES 1389: Hot-Applied Joint Sealant Systems for Concrete Pavements. Specification for Joint Sealants,

R. ES 1390: Hot-Applied Joint Sealant Systems for Concrete Pavements. Code of Practice for the Application and Use of Joint Sealants,

S. ES 1652: Workmanship on Building Sites. Code of Practice for Waterproofing.

T. ES 2031: Waterproofing of Buildings and Structures Damp-proofing against Moisture from the Ground Design and Workmanship.

U. BS EN 206-1: Concrete – Part 1: Specification, Performance, Production and Conformity,

V. BS 6213: Guide to Selection of Constructional Sealants,

W. BS 5328-1: Concrete, Part 1. Guide to Specifying Concrete.

X. ACI 301-05: Specifications for Structural Concrete.

Y. ACI 304R-00: Guide for Measuring, Mixing, Transporting, and Placing of Concrete.

Z. ACI 303R-04: Guide to Cast-in-Place Architectural Concrete Practice.

AA. ACI 302.2R-06: Guide for Concrete Slabs that Receives Moisture-Sensitive Flooring Materials.

BB. ACI 304.2R-96: Placing Concrete by Pumping Methods.

CC. ACI 305R-10: Hot Weather Concreting.

DD. ACI 306R-10: Cold Weather Concreting.

EE. ACI 224.3R-95: Joints in Concrete Construction.

FF. ACI 504R-90: Guide to Sealing Joints in Concrete Structures.

GG. ACI 308.1-98: Standard Specification for Curing Concrete.

1.03 DEFINITIONS

A. Complying with the definitions stated in BS EN 206-1:
   1. Site-Mixed Concrete: Concrete produced on the construction site by the user of the concrete for his own use.

2. Ready-Mixed Concrete: Concrete delivered in a fresh state by a person or body who is not the user.
3. Precast Concrete Product: Concrete product cast and cured in a place other than the final location of the use.
4. Normal-Weight Concrete: Concrete having an oven dry density greater than 2000 kg/m3 but not exceeding 2600 kg/m3.
5. Light-Weight Concrete: Concrete having an oven dry density of not less than 800kg/m3 and not more than 2000 kg/m3.
6. Heavy-Weight Concrete: Concrete having an oven dry density greater than 2600 kg/m3.

B. Complying with the definitions stated in BS 5328:
1. Designed Mix: Mix for which the purchaser is responsible for specifying the required performance and the producer is responsible for selecting the mix proportions to produce the specified performance.

C. Complying with the definitions stated in ACI 304.2R-96:
1. Pumped Concrete: Concrete that is conveyed by pumping pressure through rigid pipe or flexible hose.

D. Complying with the definitions stated in ACI 303R-04:
1. Architectural Concrete: Concrete that will be permanently exposed to view and that requires special care in the selection of concrete materials, forming, placing and finishing to obtain the desired architectural appearance and is designated as architectural concrete in the contract documents;

E. Complying with the definitions stated in ACI 301-05:
1. Pre-stressed Concrete: Concrete in which internal stresses of sufficient magnitude and distribution are introduced to counteract to a desired degree the tensile stresses resulting from the service loads; in reinforced concrete, the pre-stress is commonly introduced by tensioning the tendons.

1.04 SUBMITTALS

A. Except as shown or specified otherwise, comply with the requirements of BS EN 206-1: stated under section 9.9.

B. Product Data:
1. Mix Design: Submit proposed concrete design mix (mixes) together with name and location of batching plant or location of mix design before using a new concrete composition. For mix design preparation other than batching plant, the location and mix design preparation method shall be as directed by the Engineer except as shown or specified otherwise.
   a. Include test results of proposed concrete proportions based on previous field experience or laboratory trial batches.
   b. Pumped Concrete: Comply with ACI 304.2R-96, Include test results of proposed design mix (mixes) tested under actual field conditions with the maximum horizontal run and vertical lift required for this project.

2. Portland cement: Brand and manufacturer’s name for each delivery.
3. Air-entraining Admixture: Brand and manufacturer’s name for each delivery.
4. Water-reducing Admixture: Brand and manufacturer’s name for each delivery.

5. High Range Water-reducing Admixture (Super plasticizer): Brand & manufacturer's name for each delivery.
6. Water Retaining Admixture: Brand and manufacturer's name for each delivery.
7. Set Accelerating Admixture: Brand and manufacturer's name for each delivery.
8. Hardening Accelerating Admixture: Brand and manufacturer's name for each delivery.
9. Set Retarding Admixture: Brand and manufacturer's name for each delivery.
10. Water Resisting Admixture: Brand and manufacturer's name for each delivery.
11. Aggregates: Types, Pit or quarry locations, Producers' name, Grading, Specific gravities, impurities, water absorption, abrasion, etc., test results and evidences not more than 90 days old for the first delivery from new source, demonstrating compliance with the requirements of ES 2261, ES 2341 & ES 2367.
12. Chemical Hardener (Dust-proofing): Brand and manufacturer's name, and application instructions.
13. Chemical Curing and Anti-Spalling Compound: Brand and manufacturer's name, and application instructions.
14. Bonding Agent (Adhesive): Brand and manufacturer's name, and preparation and application instructions.
15. Expansion Joint Fillers: Brand and manufacturer's name for each delivery.
16. Water-stop: Brand and manufacturer's name, and installation instructions.

C. Quality Control Submittals:
1. Batching Plant & Testing Apparatus: furnish relevant certificates approved from recognized organization.
2. Batching Plant Records: At the end of each day of placing concrete, furnish the Engineer's Representative with a legible copy of all batch records for the concrete placed.
3. Concrete Pumping Equipment Data: comply with ACI 304.2R-96; include manufacturer's name and model of principal components, type of pump, and type and diameter of pipe/hose.
4. Concrete Mixer, Vibrator, Dumper Equipment Data: Include manufacturer's name and model of principal components, type and capacity of equipment
5. Proposed equipment for and methods of sampling and testing materials on site or nearest laboratory.

1.05 QUALITY ASSURANCE

A. Qualifications of Crew Pumping Concrete: Comply with ACI 304.2R-96; Workers pumping concrete shall have had at least one year of experience pumping concrete.

B. Qualifications Personnel involved in production and production control of Concrete: Complying to the requirements of BS EN 206-1 stated under section 9.6
1. Knowledge, training and experience of Personnel involved in production and production control shall be appropriate to the type of concrete, e.g. high strength concrete, light weight concrete.
2. Appropriate records of the training and experience of the Personnel involved in production and production control shall be maintained.

C. Concrete batching plants shall be currently approved certificate or license from recognized organization.

D. Testing Apparatus shall be currently approved certificate or license from recognized organization.

E. Pumping equipment for pumped concrete, Concrete Mixers, Vibrators and Dumpers shall be subject to the approval of the Engineer.

F. Source Quality Control: The Engineer reserves the right to inspect and approve the following items, at his own discretion, either with his own forces or with a designated inspection agency:
   1. Batching and mixing facilities and equipment.
   2. Sources of materials.

G. Production and Production Control Inspection: complying with the requirements stated in BS EN 206-1, section 9, the Engineer reserves the right to check whether the prerequisites for production and agreed production control are being maintained, at his own discretion, either with his own forces or with a designated inspection agency:
   1. The production, sampling and testing procedures.
   2. The record data.
   3. The test results obtained for production control during the inspection period.
   4. The required tests or procedures have been carried out with appropriate frequency.
   5. The production equipment has been checked and maintained as scheduled.
   6. The test equipment has been maintained and calibrated as scheduled.
   7. The actions taken with respect to any non-conformity.

H. Concrete from Batching Plant: Complying with the requirements stated in BS EN 206-1, section 9.3, the following legible copy of batch recorded data (documents) shall be furnished for concrete & concrete constituent materials (cement, aggregates, water, etc.,) at the end of each day of placing concrete, for the concrete placed.
   1. Composition of concrete;
      a. Concrete description.
      b. Records of masses of constituents in batch or load (e.g. cement content) used in the mix tank.
      c. Water cement ratio.
      d. Chloride content.

   2. Time loaded or of first mixing of cement and aggregates.
   3. Test of fresh concrete.
   4. For constituent materials used in the mix tank;
      a. Name of suppliers and sources.
      b. Date and test results

I. Compliance Controls: Compliance with specified properties of concrete not under production control certification shall be judged by tests as per the requirements for:
   1. Sampling and testing methods.
   2. Size of lot and frequency of sampling.
   3. Compliance criteria.

J. Pre-Construction Conference:
   1. General: At least 15 days prior to submittal of design mixes, conduct a meeting to review proposed methods of concrete construction to achieve the required results.
      a. Agenda: Includes but is not limited to:
         1) Submittals.

2) Coordination of work.
3) Availability of material.
4) Location of storage of materials.
5) Concrete mix design including admixtures.
6) Methods of placing, finishing, and curing.
7) Finish criteria required to obtain required flatness and levelness.
8) Timing of floor finish measurements.
9) If resilient flooring is to be placed on slab-on-grade, the meeting will also include discussion of curing procedures and moisture mitigation measures.
10) Attendees: Include but not limited to representatives of Contractor; subcontractors involved in supplying, conveying, placing, finishing, and curing concrete; lightweight aggregate manufacturer; admixture manufacturers; Resident Engineer; Consulting Engineer; Contracting Authority Representative; structural engineer; etc.
11) Minutes of the meeting: the Engineer shall take minutes and type and distribute the minutes to attendees within five days of the meeting.

K. Mock-up:
1. Mock-up is used only with architectural exposed concrete. Check with architect or/and contract documents for requirements.
2. Shall comply with the requirements stated in ACI 303R-04.
3. In addition to the other specified samples and tests, construct a mock-up using the materials, reinforcing, forming system and construction methods proposed for use in exposed architectural concrete.
4. Construct the mock-up with at least a 2.5 m by 2.5 m (8 feet by 8 feet) exposed surface and suitable foundations. Include the following where applicable: Control joints, ringlets, recesses or other typical architectural details.
5. Before casting the mock-up, submit full detailed Shop Drawings of the mock-up formwork for review by the Architect. Perform all necessary preliminary tests to ensure that concrete used for the mock-up will exactly match the approved sample in color and texture.
6. Perform the surface treatment proposed for use on one or more areas not less than 300 mm by 300 mm on the back side of the mock-up to establish the texture of finish required by the Architect. Repeat as required until a sample satisfactory to the Architect has been obtained.
7. Treat the finished front surface of the mock-up to produce a uniform appearance similar in every respect to the approved sample area.
8. The completed mock-up shall be inspected by the Architect. Failure of the mock-up to match the approved sample will require the construction of further mock-ups until approval is obtained. Remove rejected mock-ups immediately.
9. Maintain the approved mock-ups in good condition at the job site until all architectural concrete surfaces have been completed and approved by the Architect. Remove the mock-up from the site after completion of the work

1.06 DELIVERY, STORAGE AND HANDLING

A. Conform to the Resident Engineer for the appropriate location of storage of materials on project site.

B. Conform to ACI 304R-00. The following consideration shall be given:
1. Course and fine aggregates, cement and chemical admixtures should be properly stored, batched and handled to maintain the quality of the resulting concrete.

2. Store aggregate separately for each kind or grade, to prevent segregation of sizes and avoid inclusion of dirt and other materials.
3. Storage; Stockpiling of course aggregate should be kept to a minimum because fines tend to settle and accumulate. When stockpiling is necessary, use of correct methods minimize problems with fines, segregation, aggregate breakage, excessive variation in gradation, and contamination. Stockpiles should be built up in horizontal or gently sloping layers, not by end dumping, Trucks, loaders, and dozers, or other equipment should not be operated on the stock piles because, in addition to breaking the aggregates, they frequently track dirt onto the piles.
4. Deliver cement in original sealed containers bearing name of brand and manufacturer, and marked with net weight of contents. All cement should be stored in weather tight, properly ventilated structures to prevent absorption of moisture. Storage facilities for bulk cement should include separate compartments for each type of cement used. Store in suitable watertight building in which floor is raised at least 300 mm (1 foot) above ground. Bags of cement should be stacked on pallets or similar platforms to permit proper circulation of air. For a storage period of less than 60 days, stock the bags no higher than 14 layers, and for a longer period, not higher than seven layers. As an additional precaution the oldest cement should be used first.
5. Admixtures: Most admixtures are delivered in liquid form and should be protected against freezing. If liquid admixtures are frozen, they should be properly re-blended before they are used in concrete. Manufacturer's instructions should be followed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Shall comply with:
   1. ES 2169: for low heat Portland cement
   2. ES 2171: for sulfate - resisting Portland cement
   3. ES 2179: for pozzolanic pulverized-fuel ash cement
   4. ES 1177-2: for Cement Conformity Evaluation.

B. Water: Shall be fresh, clean and free from harmful matter.

C. Admixtures shall comply with:
   1. ES 2309: For concrete admixture requirements, conformity, marking and labeling.

D. Aggregates shall comply with:
   1. ES 2261: for building sands from natural sources.
   2. ES 2341: for aggregates in general.
   3. ES 2367: for aggregates from natural sources for concrete.
   4. ES 2275: for lightweight aggregates.

E. Moisture-Retaining Cover: Shall comply with ACI 308.1, section 2.

F. Expansion Joint Filler: Shall complying with:
   1. ACI 504R-90.
   2. ES 3735-42: For steel-filled epoxy resin based adhesive.

G. Water-stop:
   1. Rigid water stops: Shall comply with ACI 224.3R-95 Section 2.6.1.

2. Flexible water stops: Shall comply with ACI 224.3R-95 Section 2.6.2.

H. Vapor Barrier:
1. Plastic and shall comply with ACI 302.2R-06, section 7.1.1.

I. Water proofing shall comply with:
1. ES 2031: For design and workmanship of damp-proofing against moisture from the ground.
2. ES 1652: For waterproofing workmanship on building sites.

J. Joint Sealants shall comply with:
1. ES 1389: For hot-applied joint sealant systems for concrete pavements.
2. BS 6213: For joint sealants except for hot-applied joint sealant systems for concrete pavements.

2.02 PROPORTIONING OF MIXES

A. Designed Mixes: Shall comply with the requirements of BS 5328 and the following essential items shall be defined:
1. The mix to be supplied is designed mix and in accordance with the relevant clauses of BS 5328: Part 2, 3 and 4.
2. The grade, which shall be one of the values given in table 1 and 2 as appropriate of BS 5328-2.
3. The required nominal maximum size of aggregate.
4. The permitted type(s) of aggregate.
5. The permitted type(s) of cement.
6. The minimum cement content.
7. The maximum free water/cement ratio.
8. The workability.
9. Any quality assurance requirements.
10. The method of placing the concrete.
11. The rate of sampling.

B. Water-Cement Ratio:
1. The maximum water-cement ratio shall be assessed using workability test results.
2. The maximum water-cement ratio shall be reassessed for periodically for conformation. Special attention shall be given when there is a change in water content of aggregate and admixtures.

C. Admixtures: Do not use admixtures in concrete unless specified or approved in writing by the Engineer.

D. Mixture Proportions:
1. Mix Designs: Proportioned in accordance with Section 5.3.2, table 6, "Guidance on mix design limits for durability of concrete made with normal weight aggregates of 20mm nominal maximum size" of BS 5328-1.
2. Trial Mixes: Conformation shall be required for the adequacy of proposed mix proportion to check for the satisfaction of the requirements.
   a. The accuracy of mix proportion shall be checked regularly and the consistency of the fresh concrete shall be checked periodically with the slump test. The compliance control for sampling and testing, size of lot and frequency of sampling, the compliance criteria shall be as per the Contract requirements.

3. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, admixtures, weight and gradation of fine and coarse aggregate, specific gravity, fineness modulus, percentage of moisture, air content, water cement ratio, and consistency of each cylinder in terms of slump.
4. Submit proposed design mix (mixes) for pumped concrete and the pumping equipment shall have been tested under actual field conditions with the maximum horizontal run and vertical lift required for this project.

E. Air Content:
1. When the air content of fresh concrete is to be determined, it shall be tested as per ES 2374.

F. Minimum cement content:
1. Comply with the requirements of BS 5328.

G. Maximum cement content:
1. Comply with the requirements of BS 5328.

2.03 JOINTS

A. Shall comply with ACI 504R:

B. Expansion Joints and Contraction Joints:
1. Except as shown or specified otherwise, the type of expansion joints and contraction joints shall comply with the requirements of ACI 504R.
   a. Provide contraction (control) joints as indicated on the contract drawings. The necessary plane of weakness may be formed either by partly fully reducing the concrete cross section. Joints shall be done by installing thin metallic, plastic or wooden strips when the concrete is placed or by sawing the concrete soon after it has hardened.
   b. Install acceptable joint sealant materials, as shown in accordance with manufacturer's instructions.

C. Construction joints and other bonded joints:
1. Except as shown or specified otherwise, the type of construction joints and other bonded joints shall comply with the requirements of ACI 504R.
   a. Locate construction joints as indicated in project drawings
   b. Remove laitance and thoroughly clean and dampen construction joints before placement of fresh concrete.
   c. Formed construction joints shall meet requirements stated in ACI 301-05.
   d. When bond is required or permitted, use one of the following methods;
      1) Use an acceptable adhesive applied in accordance with the manufacturer’s recommendations;
      2) Use an acceptable surface retarder in accordance with manufacturer’s instructions.
      3) Roughen the surface in an acceptable manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregates, or damaged concrete at the surface, or
      4) Use Portland cement of grout of the same proportions as the mortar in the concrete in an acceptable manner.

5) All construction joints shall be made against approved forms placed in position as indicated.
6) All construction joints in water retaining structures shall have approved built in water stops. The positions are to be agreed before construction commences

PART 3 EXECUTIONS

3.01 EXAMINATION AND PREPARATION

A. Except as shown or specified otherwise, the following examinations and preparations shall be performed complying with the requirements stated in ACI 301-05, section 5.3.

B. Do not begun concrete until data on materials and mixture proportions are accepted.

C. Remove hardened concrete and foreign materials from the inner surfaces of conveying equipment.

D. Do not use items of aluminum for mixing, cutting, conveying, forming or finishing concrete, except magnesium alloy tools may be used for finishing.

E. Check items of aluminum required to be embedded in the concrete and insure that they are coated, painted or otherwise isolated in an approved manner.

F. Before placing concrete in forms, complete the following:
1. Comply with formwork requirements specified in Section 031100.
2. Prior to placement of concrete, remove all hardened concrete spillage and foreign materials from the space to be occupied by the concrete.
3. Comply with reinforcing steel placement requirements specified in Section 032100.
4. Position and secure in place expansion joint materials, anchors, and other embedded items.

G. Install water-stops in accordance with manufacturer’s printed instructions.

H. Hardened concrete, reinforcement, forms, and earth which will be in contact with fresh concrete shall be free from frost at the time of concrete placement.

I. Do not deposit fresh concrete in water. Keep excavations free of water by pumping or by other approved methods.

J. Prior to placement of a concrete slab on ground, remove foreign materials from the subgrade and complete the following.
1. Subgrade shall be well drained and of uniform load-bearing nature.
2. In-place density of subgrade soils shall be uniform throughout the area and at least the minimum required by the Contract Documents.
3. Subgrade shall be free from frost and ice.
4. Subgrade shall be moist with no free water and no muddy or soft spots.

K. The surface preparation for concrete slabs that receive moisture sensitive flooring materials shall conform to the requirements of ACI 302.2R-06, section 9.6. For vapor retarder/barrier location, comply with ACI 302.2R-06, section 7.2.

L. When high evaporative conditions necessitate protection of concrete immediately after placing or finishing, make provisions in advance of concrete placement for wind breaks, shading, fogging, sprinkling, ponding, or wet covering.

M. Obtain acceptance of finished preparation.

3.02 USE OF ADMIXTURES

A. Shall comply with the requirements stated in BS EN 206-1, section 5.2.6.

B. The total amount of admixtures, if any, shall not exceed the maximum dosage recommended by the admixture producer and not exceed 50g of admixture (as supplied) per kg cement unless the influence of the higher dosage on the performance and the durability of the concrete is established:

C. Admixtures used in quantities less than 2g/kg cement are only permitted if they are dispersed in part of the mixing water.

D. If the total quantity of liquid admixtures exceeds 3l/m3 of concrete, its water content shall be taken in to account when calculating the water/cement ratio.

E. When more than one admixture is used, the compatibility of the admixtures shall be checked in the initial tests.

3.03 PLACING

A. Shall comply with the requirements of ACI 301-05.

B. Weather Considerations;
   1. Do not begun to place concrete while rain, sleet or snow is falling unless adequate protection is provided and when required, acceptance of protection is required. Do not allow rain water to increase mixing water or to damage the surface of the concrete
   2. Provide adequate controls to insure that the temperature of the concrete when placed does not exceed 90 degrees F and make every effort to place it at a lower temperature. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set or cold joints. Ingredients may be cooled before mixing by shading the aggregates, fog spraying the coarse aggregate, chilling the mixing water or other approved means. Mixing water may be chilled with flake ice or well-crushed ice of a size that will melt completely during mixing, providing the water equivalent of the ice is calculated into the total amount of mixing water.
   3. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement and curing.
      a. In cold weather, comply with ACI 306R.
      b. In hot weather, comply with ACI 305R.

C. Conveying equipment:
   1. Use acceptable conveying equipment of a size and design that will prevent cold joint from occurring. Clear conveying equipment before each placement.

2. Use appropriate conveying equipment that are horizontal or at slope that will not cause excessive segregation or loss of ingredients.
3. Protect concrete to minimize drying and effects of temperature rise.

D. Conveying:
1. Concrete shall be conveyed from the mixer to the point of deposit, in such a manner as to prevent segregation or loss of ingredients, and placed in position not more than 30 minutes after the first wetting of cement in any one batch.

E. Depositing:
1. Deposit concrete continuously in one layer or in layers to have fresh concrete deposited on in-place concrete that is still plastic
2. Do not deposit fresh concrete on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section, unless construction joint requirements (2.02 C above) are met
3. Do not use concrete that has surface-dried, partially hardened or contain foreign materials
4. Unless specially permitted, concrete shall not to be dropped in from a height exceeding 1.30rn.
5. Place concrete as near as practicable to the final position to avoid segregation.

F. Consolidating:
1. Consolidate concrete by vibration. Thoroughly work concrete around reinforcement and embedded items and into corners of forms, eliminating air and stone pockets that may cause honeycombing, pitting, or panes of weakness.
2. Workers shall be experienced in the use of the vibrator.
3. Do not use the vibrators to move concrete within the forms.

3.04 REPAIRING SURFACE DEFECTS

A. It shall comply with:
1. ES 1682: for cleaning and surface repair concrete.

3.05 FINISHING FORMED SURFACES

A. After removal of forms, give each formed surface one or more of the finishes described below complying with the requirements stated in ACI 301-05.

B. As-cast Finishes: Use form-facing materials meeting the requirements in the formwork section of this Specification. Produce one of the following finishes as required by the finished schedule:
1. Rough Form Finish: patch tie holes and defects. Chip or rub off fins exceeding ½ in. in height. Leave surfaces with the texture imparted by the forms.
2. Smooth Form Finish: patch tie holes and defects. Remove fines exceeding 1/8 in. in height.

C. Rubbed Finishes: remove forms as early as possible. Produce one of the following finishes as required by the finished schedule:
1. Smooth Rubbed Finish: remove forms as early as possible and perform necessary patching. Produce finish on hardened concrete not later than a day following formwork removal. Wet the surface and rub it with carborundum brick or other

abrasive until uniform color and texture are produced. Use no cement grout other than cement paste drawn from the concrete itself by the rubbing process.

2. Grout Cleaned Finish: begun cleaning operations after contiguous surfaces to be cleaned are completed and accessible. Do not clean surfaces as work progresses. Wet the surface and apply grout consisting of one part Portland cement and one and one-half parts of fine sand with enough water to produce the consistency of thick paint. Match color of surrounding concrete. Scrub grout into voids, and remove excess grout.

D. Finish Schedule: Except where indicated otherwise on the Contract Documents, provide the finishes below:
   1. Rough Form Finish for concrete surfaces not exposed to public view.
   2. Smooth Form Finish for concrete surfaces exposed to public view.
   3. Smooth Rubbed Finish for exterior concrete surfaces exposed to view.
   4. Grout Cleaned Finish for interior concrete surfaces exposed to view.

E. Fins shall be completely removed on surfaces to receive waterproofing.

F. Vertical and Overhead Surface Finishes:
   1. Unfinished areas: Except where indicated otherwise on the contract documents, vertical and overhead concrete surfaces exposed in pipe basements, elevator and dumbwaiter shafts, pipe spaces, pipe trenches, above suspended ceilings, manholes, and other unfinished areas will not require additional finishing.
   2. Interior and exterior exposed areas to be painted: Remove fins, burrs and similar projections on surfaces flush, and smooth by mechanical means approved by Resident Engineer, and by rubbing lightly with a fine abrasive stone or hone. Use ample water during rubbing without working up a lather of mortar or changing texture of concrete.
   3. Interior and exterior exposed areas finished: Give a grout finish of uniform color and smooth finish treated as follows:
      a. After concrete has hardened & laitance fin and burrs removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone stone.
      b. Apply grout composed of one part of Portland cement, one part fine sand, smaller than a 600 μm (No. 30) sieve. Work grout into surface of concrete with cork floats or fiber brushes until all pits, and honeycombs are filled.
      c. After grout has hardened slightly, but while still plastic, scrape grout off with a sponge rubber float and, about 1 hour later, rub concrete vigorously with burlap to remove any excess grout remaining on surfaces.
      d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish of area in same day. Make limits of finished areas at natural breaks in wall surface. Leave no grout on concrete surface overnight.

G. Architectural Finishes:
   1. Produce architectural finishes including special textured finishes, exposed aggregate finish, and aggregate transfer finish as shown on the drawings or as per the requirements stated in ACI 303R-04.

3.06 FINISHING UNFORMED SURFACES

A. Except where indicated otherwise on the Contract Documents, finishing surface requirements shall comply with ACI 301-05 and tolerance for surface floors shall comply with ACI 117.

B. Placement: Place concrete at a rate that allows spreading, straight-edging, and derbying or bull-floating before bleed water appears. Strike smooth the top of walls, buttresses, horizontal offsets, and other similar unformed surfaces and float them to a texture consistent with finish of adjacent formed surface. Use qualified flatwork finishers acceptable to the Architect/Engineer.

C. Slab Finishes :
   1. Placement, measurement, evaluation and adjustment of procedures to produce slabs within specified tolerances shall comply with the requirements stated in ACI 302.

D. Finishes and Tolerances: The concrete surface shall be finished in either of the following ways as indicated in the Contract Documents or directed by the Engineer.
   2. Trowel Finish: Trowel finish shall be done using power driven trowel. The final trowel shall be handmade and left free from trowel marks. Continue hand-troweling until a ringing sound is produced as the floor is troweled. Tolerance for concrete floors shall be conventional straight-edged tolerance in accordance with ACI 117 unless otherwise specified.
   3. Float Finish: place, consolidate, strike-off, and level concrete, eliminating high spots and low spots. Do not work concrete further until it is ready for floating. Floating shall be machine or hand operated depending upon the convenience of the area to be floated. Produce a finish that will meet conventional straight-edged tolerance requirements of ACI 117, and then refloat the slab immediately to a uniform texture.
   4. Where non-slip brown finish is to be applied, the concrete surface shall be slightly roughened immediately after trowel finish by broom in the direction perpendicular to the main traffic using a fiber bristle broom.
   5. Scratch Finish: Where scratch finish is to be applied, the concrete surface shall, after leveling be scratched using stiff broom or brush for surfaces to receive bond applied cement based finish material. Produce a finish that will meet conventional bull-float tolerance requirements of ACI 117.
   6. Where bush hammer finish is to be applied, the concrete surface shall be pooled with a power driver hammer or manually to expose aggregate as directed. Care shall be taken to preserve arises. The surface shall be wire brushed and washed down on completion.
   7. Broom Finish: Finish exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after surfaces have been floated. Brush in a direction transverse to main traffic. Match texture approved by Resident Engineer from sample panel.

E. Finish Schedule: Except where indicated otherwise on the Contract Documents, provide the finishes below:
   1. Scratch Finish: for surfaces intended to receive bonded cementitious mixtures.
   2. Trowel Finish: for floors intended as walking surface, floors in manufacturing, storage, and warehousing areas, or for reception of floor coverings. It can be applied to slab surfaces exposed to view and surfaces to be covered with resilient flooring, carpeting, paint or other thin floor coating.
   3. Broom or Belt Finish: for exterior slabs. Texture as approved by the Engineer's Representative.
   4. Floated Finish for:
      a. Treads and platforms of exterior steps and stairs,
      b. Slabs and fill over which waterproofing, roofing, vapor barrier, insulation, terrazzo, or resin bound flooring is required.

3.07 CURING AND PROTECTION

A. Curing of concrete generally complying with the requirements stated in ACI 308.1.

B. Concrete shall be protected from premature drying and excessively hot temperatures for at least 28 days from the date of casting. The concrete surface shall be kept continuously wet by application of water for at least 7 days to maintain constant temperature. The watering of concrete shall continue until the concrete has achieved its designed strength. Where the temperature is excessively high the surface of concrete shall be covered with materials as indicated on the Contract Documents, or plastic sheets or reinforced paper continuously kept wet or the application of other moisture retaining covering as approved by the Engineer. Where the surface of concrete is covered with formwork, the surface of the form shall be wetted until-removed.

C. Hot Weather Concreting: Comply with ACI 305R whenever the atmospheric temperature or the form surface temperature is at or above 90 degrees F. or climatic conditions of wind and/or low humidity will cause premature drying of the concrete.

D. Cold Weather Concreting: Comply with ACI 306R

E. Curing Temperature: Maintain the temperature of the concrete at 50 degrees F. or above during the curing period. Keep the concrete temperature as uniform as possible and protect from rapid atmospheric temperature changes. The temperature of the curing water shall not be more than 10 C cooler than the surface temperature of the concrete at the time water and concrete come in contact.

F. Curing and Protection of concrete floor slab:
   1. Method of curing complying with ACI 3021r_96 section 9.2.
   2. Curing at joints: complying with ACI 3021r_96 section 9.3.
   3. Length of curing: complying with ACI 3021r_96 section 9.5.

3.08 CHEMICAL HARDENER (DUSTPROOFING)

A. Perform the following if it is indicated in the Contract Documents;
   1. Apply chemical hardener to all trowel finished interior floors which are to be left exposed.
   2. Do not apply chemical hardener until concrete has cured the number of days recommended in manufacturer’s instructions.
   3. Prepare surfaces and apply chemical hardener in accordance with manufacturer’s printed instructions and recommendations.

3.09 INSTALLATION OF JOINT SEALANTS

A. Shall comply with the requirements of ES 1390 for the application and use of hot-applied joint sealant systems for concrete pavements,

B. Shall comply with the requirements stated in ACI 504R except for the application and use of hot-applied joint sealant systems for concrete pavements,

C. The steps and methods of constructing the joint and sealing it must be kept as per the requirements.
   1. Joint faces shall be clean and free of defects that would impair bond with field molded sealants or prevent uniform contact of performed sealants.
   2. Joint faces shall be dry since the sealant has to bond with the concrete except claimed by sealant manufacturers.
   3. Ensure the joints are sufficiently clean and dry and check the joint width and temperature prior to placing backup materials, priming or sealant installation.

3.10 FIELD QUALITY CONTROL

A. Comply with the requirements stated in the Contract Documents including the requirements stated in this Section.

B. Testing Services:
   1. Review and check test proposed materials for compliance with contract documents
   2. Review and check test proposed concrete mixture as required by the Architect/Engineer.
   3. Obtain production samples of materials at plants or stockpiles during the course of the work and test for compliance with the contract documents.
   4. Conduct concrete strength test during construction as per the requirement.
   5. Strength Tests for Pumped Concrete: Prepare strength test specimens and make strength tests from concrete samples obtained at the truck discharge chute and at the end of the pump delivery line.

C. Tests required by the Contractor: unless otherwise specified in the contract documents, the contract shall provide, at no cost to the Contracting Authority the necessary testing services of:
   1. Qualification of proposed materials and establishment of concrete mixtures
   2. Other testing services needed or required by contractor.
   3. Make available to the Engineer's Representatives whatever test samples are required to make tests.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to the Contracting Authority and as accepted by the Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Engineer's Representative before using in the work.

E. Test results will be reported in writing to the Engineer's Representative, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing laboratory, concrete type and class, location of concrete batch, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

F. Nondestructive Testing: Impact hammer or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

G. Moisture Testing: Test all slabs-on-grade for moisture content that will receive resilient flooring as per the concrete moisture testing requirements stated in ACI 302.2R-06,

whenever conformation is required by the Engineer. For a preferred moisture testing method and limits; consult the written instructions of the floor covering manufacturer, the adhesive manufacturer, the patching/underlayment manufacturer, or combination thereof. Test repeatedly until the desired moisture content is obtained.

H. pH Testing: as per the request of the Engineer or Contract Documents, test concrete floors that receive moisture sensitive flooring materials for pH level prior to the installation of resilient flooring complying with the concrete pH testing requirements stated in ACI 302.2R-06. Do not exceed the recommended pH level of the resilient flooring manufacturer or the adhesive manufacturer, or both.

I. Cement shall be used in the order delivered. It shall be visually checked and tested, when required by the Engineer, before being used. Set or partially set cement bags shall be immediately removed from the site. Further tests for fineness and compressive strength for consignment already delivered shall be made when required by the Engineer.

J. Rejected samples of aggregates shall be removed from the site within 24 hours.

K. Hand mixing of concrete shall not be done.

3.11 TOLERANCES

A. Tolerances of concrete dimensions for structural safety, concrete cover, and others shall comply with the requirements of applicable Referenced Standards.

END OF SECTION

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SECTION 034100

STRUCTURAL PRECAST CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The provisions of this Section apply to all non-pre-stressed, precast structural concrete members.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Reinforcement: Section 032100.

B. Cast-In-Place Concrete: Section 033000.

1.03 REFERENCES

A. EBSC – 2 (EBSC EN 1992-1-1:2015): Ethiopian Building Code of Standard, Structural Use of Concrete.

B. ES 3137: Structural Use of Concrete - part 1: Code of Practice for Design and Construction.

C. ES 3149: Code of Practice for Design and Installation of Non-Load Bearing Precast Concrete Cladding.

D. ES 2380: Common Rule for Precast Concrete Products.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Submit fully dimensioned fabrication and erection drawings. Drawings shall show all markings, details of shape, connections, plates, inserts, clearances, openings and other requirements of the Contract drawings. Requirements and details for handling and erection shall also be shown.
   2. Design Calculations: Unless otherwise noted on the Drawings or herein specified, calculations showing the stresses in the steel and concrete, based on the moments and shears obtained from the loading shown on the Contract Drawings, and the construction, handling and erection procedures, shall be submitted with the shop drawings.
   3. Fabrication shall not be started until shop drawings have been approved.
      a. Where drawings are “Approved as Noted” and specimen samples as described in B here under are fulfilled, fabrication may be progressed in conformity with the notes thereon, but revised copies shall be submitted for formal approval and record.

B. Before fabrication in bulk, specimen samples of precast units shall be submitted for approval, with which further deliveries or castings shall be compared for uniformity of color and finish.

1.05 QUALITY ASSURANCE

A. Qualifications of Precast Structural Concrete Manufacturer: All Work included herein shall be manufactured by and installed under the supervision of a competent and reputable manufacturer who shall produce a Precast Structural Concrete Product similar and equal to the Standard product (with modifications as shown).

B. Shop Inspection:
   1. The Procuring Entity reserves the right to provide shop inspection of all phases of the Work to insure conformity with the Drawings, Specifications and related Standards. Such inspection will be performed by an inspection laboratory or Engineer designated by the Procuring Entity. Representatives of such inspection laboratory or Engineer/Procuring Entity shall be provided free and easy access to the plant at all times that Work is in progress. Such inspection will be provided without cost to the Contractor and shall not be included in the bid price.
   2. It shall be the responsibility of the Contractor to plan and schedule his Work and the Work of his sub-contractors, and to keep the inspection laboratory or Engineer and the Procuring Entity's Representative informed of such plans and schedules, in order to minimize the cost to the Procuring Entity of such inspection. Whenever failure by the Contractor or his sub-contractor to so plan, schedule and perform his Work and to coordinate with the inspection laboratory or Engineer, results in excessive inspection costs, the Procuring Entity reserves the right to back-charge such excess cost to the Contractor.

C. Design:
   1. Design procedure, requirements and allowable stresses shall conform to 'Ethiopian Building Code of Standard for Structural Use of Concrete (EBSC)' as currently revised.
      a. Dimensional deviations of precast concrete members from details shown on the drawing shall not exceed from the permissible dimensional deviations stated in ES 3137.
      b. Care should be taken that the permissible deviations for the units are consistent with the variations in the position of adjoining components in the building.

D. Concrete Test:
   1. Standard concrete tests shall be made with the fabricator's equipment under the supervision of the inspecting laboratory or Engineer. A minimum of one test for slump, one air content determination test and three compression test cylinders/cubes shall be taken from the first pour of concrete is placed. Also one slump test and one air content determination shall be taken from the first pour of concrete after on each day of concrete are placed. Additional compression test cylinders/cubes shall be taken, and additional tests made for slump and air content at the discretion of the Engineer's Representative. Each cylinder/cube shall be so marked that it can be identified with the precast item made from the same concrete batch.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Precast items shall be handled, lifted and/or supported at points shown on the approved shop drawings or at supporting points at which the Work will set when in service. Such supporting points shall insure against any detrimental deflection, overstressing and cracking or chipping of concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Portland cement, aggregates, water and air entraining agents shall be as specified under the Cast-In-Place Concrete Section. Air entraining cement shall not be used. Reinforcement shall be as specified under The Concrete Reinforcement Section.

B. Concrete:
   1. Apply the rules as per the requirements of ES 2380 for the production of precast concrete members, except as otherwise indicated on the Drawings.

C. Reinforcement bars:
   1. Unless specified otherwise, use the appropriate type of reinforcement bars specified under the Steel Concrete Reinforcement Section for precast concrete product.

2.02 FABRICATION

A. All precast concrete items shall be shop fabricated in accordance with these Specifications and with the Contract Drawings. Work shall not proceed until approval of the proposed fabricator has been given by the Procuring Entity or Engineer.

B. Forms for precast items shall be of rigid construction, true in required shape and provide close control of dimensions and details shown on approved shop drawings. They shall be thoroughly cleaned and prepared before each casting. Forms shall be constructed with tight joints and smooth surfaces and in a manner that will permit removal without defacing the cast concrete.

C. All reinforcing shall be free from loose and flaky rust, oil, grease and other coatings. Reinforcing shall be accurately positioned and securely held in place by devices that will not be exposed on or mar exposed surfaces.

D. All plates, inserts, etc., shall be galvanized. They shall be provided, located and anchored as required by the Contract and approved shop drawings.

E. Precast Concrete shall be concrete of specified class and compacted and vibrated as required to insure contact with all of the reinforcement and to flow the concrete in place completely filling all corners and angles of the forms. Molds shall not be removed until at least seven days after placing the concrete. The sides may be removed after three days provided that the molds are such that the sides are easily removable without damaging the concrete.

F. Precast work shall be cast under sheds and shall remain in there while in the molds and a further seven days after removal from the molds. During the whole of this period, the concrete shall be shielded and kept wet by sacking or other approved means. It may then be removed from the sheds and stacked in the open, until the end of the cure period or used.

G. After removal from the forms precast items shall be moist cured and protected from premature drying.

H. Unless specific dimensions are given, precast work shall be cast in lengths convenient for handling. The precast units shall have adequate strength to resist over stressing and damage during handling and erection. Care shall be taken to ensure that the units are not chipped or damaged.

I. Architectural, structural and services drawings shall be examined to determine dimension and location of holes.

J. Permission to form holes in precast units after casting shall not normally be given, but exceptional cases where the structural soundness of the perforated unit and its visual acceptability satisfactory such permission may be given in writing.

K. Precast units shall be clearly marked immediately after casting or de-molding showing identification of the unit. The marking is to be located so that it is not visible after erection.

PART 3 EXECUTION

3.01 ERECTION

A. Erection shall be done under the direct supervision of the manufacturer by workers skilled in this type of Work. The manufacturer shall examine all surfaces of the Work on which his Work is to bear, to see that they are in proper condition and location for installation of his Work prior to starting erection. The precast Work shall there-on be placed, plumbed, leveled, and fastened as shown on the approved shop drawings.

B. Precast units shall be hoisted, placed in position and fixed in such a way as to avoid over stressing or damage to neither the units nor causing damage to previously erected structure. Where shown, the unit shall be laid on thin bed of cement-sand mortar in order to even out irregularities of supporting members.

END OF SECTION

Ministry of Construction

SECTION 034133

PRECAST PRESTRESSED CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The provisions of this Section apply to precast pre-tensioned concrete sections, indicated on the Drawings, and referred to in this Section as precast pre-stressed units.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-In-Place Concrete: Section 033000.

B. Structural Precast Concrete: Section 034100.

C. Joint Sealants: Section 079200.

D. Construction Painting: Section 099101.

1.03 REFERENCES

A. EBSC – 2 (EBSC EN 1992-1-1:2015): Ethiopian Building Code of Standard, Structural Use of Concrete.

B. ES 3137: Structural Use of Concrete - part 1: Code of Practice for Design and Construction.

C. ES 3281: Execution of Concrete Structures – Part 1: Common.

D. ES 3149: Code of Practice for Design and Installation of Non-Load Bearing Precast Concrete Cladding.

E. ES 2380: Common Rule for Precast Concrete Products.

F. ES 2220: Grout for Pre-stressing Tendons – Grouting Procedures.

G. ES 2222: Grout for Pre-stressing Tendons – Specification for Common Grout.

H. ES 2341: Aggregates for Concrete.

I. ES IS0 6934-1: Steel for the Pre-stressing of Concrete. Part 1 – General Requirement

J. ES ISO 6934-3: Steel for the Pre-stressing of Concrete. Part 3: – Quenched and Tempered Wire.

K. ES ISO 6934-4: Steel for the Pre-stressing of Concrete. Part 4: – Strand.

L. ES ISO 6934-5: Steel for the Pre-stressing of Concrete. Part 5: – Hot Rolled Steel Bars with at Subsequent Processing.

M. ES ISO 69342: Steel for the Pre-stressing of Concrete. Part 2 – Cold Drawn Wire.

N. ES 2309: Admixtures for Concrete, Mortar and Grout. Part 2: Concrete Admixtures. Definitions. Requirements, Conformity, Marking and Labeling.

O. ES 1496: Guide to Accuracy in Building.

P. ENV 1992-1-1: Euro-code 2: Design of Concrete Structures – Part 1: General Rules and Rules for Buildings.

1.04 DESIGN REQUIREMENTS

A. Design of Pre-stressed Units: As per the requirements of Contract Documents.

B. Design Loads: Indicated on the Drawings.

C. Design procedure and allowable stresses shall conform to EBSC – 2, unless otherwise specified.

D. Dimensional deviations for pre-stressed units from details shown on the drawing shall not exceed from the permissible dimensional deviations stated in ES 3137.

1.05 SUBMITTALS

A. Submittals Package: Submit the shop drawings and design data specified below at the same time as a package.

B. Shop Drawings: Submit fully dimensioned fabrication and erection drawings. Include details of clearances, arrangements, piece markings, reinforcing, weld plates and welding, inserts, anchors, connections, accessories, joints, openings, and other requirements. When shop drawings are "Approved as Noted", promptly resubmit copies of corrected drawings for final approval and record.
   1. Erection Drawings:
      a. Plans and/or elevations locating and defining material furnished by manufacturer.
      b. Sections and details showing connections, cast-in items and their relation to structure.
      c. Description of all loose, cast-in and field hardware.
      d. Field installed anchor location drawings.
      e. Erection sequences and handling requirements.
      f. Dead, live and other applicable loads used in design.

   2. Production drawings:
      a. Elevation view of each member.
      b. Sections and details to indicate quantities and position of reinforcing steel, anchors, inserts, and essential embedded hardware.
      c. Lifting and erection inserts.
      d. Dimensions and finishes.
      e. Pre-stress for strand and concrete strengths.
      f. Estimated cambers.
      g. Method of transportation.

C. Quality Control Submittals:

1. Design Data: Submit pre-stress design calculations. Calculations shall include the complete design, including the stresses in steel and concrete, based on moment and shears obtained from loads shown on the Drawings and from construction and erection procedures. Indicate deflections and cambers of pre-stressed units. Design calculations shall be prepared under the direction of, and sealed by; a licensed Professional Structural Engineer.
2. Product Design Criteria:
   a. Loadings for design:
      1) Initial handling and erection stresses.
      2) Dead and live loads as specified on Contract Drawings.
      3) Other loads specified for member where they are applicable.
      4) Deflection of precast members shall be limited as required by the Code or Standard unless specified in the Contract Documents.
      5) Design shall provide for thermal movements of completed structure.
      6) Design calculations of products shall be performed by a registered Professional Engineer experienced in precast pre-stressed concrete design.
      7) Design shall be in accordance EBSC – 2.
      8) Details for waterproof joints between precast members.

3. Mix Designs: Submit proposed concrete mix designs and appropriate test data for pre-stressed concrete prior to start of fabrication. Concrete mixes shall be established as specified in Cast-in-Place Concrete Section.
4. Permissible Design Deviations:
   a. Design connections according to the conceptual details shown in the Contract Documents.
   b. Design deviations will be permitted only after Resident Engineer's written approval of manufacturer's proposed design supported by complete design calculations and drawings.
   c. Design deviations shall provide an installation equivalent to basic intent without incurring additional cost to the Procuring Entity.

5. Test Reports: Concrete and other material.
6. Submit load-strain curves of the pre-stressing steel delivered, or other data from which the elongations appropriate to the required pre-stressing force can be determined. The calculated elongations of each pre-stressing strand in each pre-stressed unit shall be submitted prior to stressing of the strands.
7. Name of the person who will be supervising the installation of the work and their employer’s name, business address and telephone number.
8. Names and addresses of five similar projects for which the supervisor has supervised the installation of pre-stressed units.

1.06 QUALITY ASSURANCE

A. Manufacture: Pre-stressed units shall be plant fabricated unless specified otherwise in the Contract Documents.

B. Manufacturer's Qualifications: The manufacturer of the pre-stressed units shall be regularly engaged in the production of such products.

C. Installer's Qualifications: The person supervising the installation of the work of this Section shall be experienced in pre-stressed concrete work, and shall have been regularly employed for a minimum of three years by a company engaged in the fabrication and installation of pre-stressed units.

D. Welders' Qualifications: Welding shall be performed only by experienced welders.

E. Source Quality Control:
   1. The manufacturer's plant, equipment, personnel, design, fabrication techniques, testing, inspection and records shall comply with applicable Standard, unless otherwise indicated.
      a. Concrete Test Cylinders/Cubes: Failure of test cylinders to develop required minimum compressive strength shall be cause for rejection of the pre-stressed units made from the concrete represented by the cylinders.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The transport and storage of tendons shall comply with the requirements stated in ES 3281.

B. Delivery: Load, transport, and unload pre-stressed units by methods that will prevent damage.

C. Storage: Store pre-stressed units on firm surfaces off the ground. Support pre-stressed units at points comparable to design support conditions.
   1. Store all units off ground.
   2. Place stored units so that identification marks are discernible.
   3. Separate stacked members by battens across full width of each bearing point.
   4. Stack so that lifting devices are accessible and undamaged.
   5. Do not use upper members of stacked tier as storage area for shorter member or heavy equipment.

D. Handling: Lift and support pre-stressed units at the points shown on the approved shop drawings or at the supporting points on which the units will set when in service.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Except specified in the contract Documents otherwise use Ordinary Portland cement product stated in Cast-in-Place Section.

B. Aggregates: Shall comply with ES 2341.

C. Water: Fresh, clean, and free from injurious amounts of oils, acids, alkalis, salts, organic material, or other deleterious substances.
   1. Mixing water, including that contributed by the aggregates, shall not contain a deleterious amount of chloride ion.

D. Air-entraining Admixture: The admixture shall be of approved quality and shall comply with ES 2309:2005 except otherwise specified in the Contract Documents.

E. Pre-stressing Steel and Tendons: Generally, unless specified otherwise, the tendons, pre-stressing steel (wires, strands, and bars) and pre-stressing devices (anchorages, couplers, sheaths and ducts) shall conform to the requirements stated in ES IS0 6934-1 or 6.3.4 of ENV 1992-1-1 and the following as appropriate:
   1. Hot rolled steel bars shall conform to ES ISO 6934-1.
   2. Quenched and tempered wire shall conform to ES ISO 6934-3.
   3. Cold drawn wire shall conform to ES ISO 69342.
   4. Strand shall conform to ES ISO 6934-4.

F. Shop Paint: As required by the Contract Documents.

2.02 CONCRETE MIXES

A. Strength: The minimum compressive strength of concrete shall be attained and comply with the requirements of ES 2380, except as specified otherwise indicated on the Drawings.

B. Air-Entrainment: Use air-entraining admixture, not air-entrained cement.

2.03 GROUT MIXES

A. Shall comply with the requirements stated in ES 2222 and the grouting procedures shall comply with ES 2220.

2.04 FABRICATION

A. Forms shall be designed and constructed to insure close control of dimensions and details shown on the Drawings, and in a manner that will not restrict movement of the casting when pre-tensioning forces are released. Forms shall be constructed with tight joints and in a manner that will permit removal without defacing the cast concrete. Forms shall leave smooth cast surfaces, unless otherwise indicated. Thoroughly clean forms and apply approved form release coating before each casting.

B. String tendons by a method which will avoid rotations in the tendon. Take care to keep tendons clean and dry.

C. Accurately locate and securely anchor reinforcing steel, weld plates, inserts, and other required embedded items with devices that will not be exposed on or mar exposed surfaces of pre-stressed units. Embedded items shall be free of loose and flaky rust, and free of oil, paint and other coatings.

D. Pre-stressing shall be done in accordance with ES 3137, unless otherwise indicated.
   1. The tensioning process shall be so conducted that the tension being applied and elongation of the tendons may be measured at all times.
   2. The transfer of the pre-stressing force to the concrete unit shall not be done before the concrete has attained the strength required by the calculations; the concrete strength shall be confirmed by the testing of cylinders made from the same concrete as the unit to which the pre-stress force is to be applied. The application of the pre-stress force to the concrete shall be done smoothly and gradually.

E. Place and consolidate concrete. Concrete shall be compacted and vibrated as required to insure full contact with embedded items and to completely fill corners and angles of the forms.

F. Finish unformed concrete surfaces smooth, unless otherwise indicated.

G. After casting or completion of surface finishing, pre-stressed units shall be cured as per the curing requirement methods of the Standard or as stated in the Contract Documents.

H. Apply one coat of paint to all surfaces of ferrous metal which will not be embedded in concrete or masonry.

I. Fabrication Tolerances: Shall conform to the recommended dimensional tolerances stated in ES 3137.

2.05 SOURCE QUALITY CONTROL

A. Plant Inspection: Inspection by the Procuring Entity of all phases of fabrication may be made at the discretion of the Engineer. Representatives of the Engineer and/or inspection laboratory designated by the Engineer shall be given access to the plant at all times that Contract Work is in progress. Inspections will be made without cost to the Contractor.
   1. Plant inspection by the Procuring Entity shall not relieve the manufacturer of responsibility for his own inspection program.
   2. Schedule, coordinate and perform the plant fabrication in a manner to minimize the cost to the Procuring Entity for inspection. When failure to perform the Work on schedule or to coordinate the schedule in advance with the inspectors results in excessive inspection costs, the Procuring Entity will back-charge such excess cost to the Contractor.

B. Verification of Performance: Do not ship pre-stressed units to the site until the units have attained sufficient strength to support erection and anticipated construction loads.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine surfaces to receive pre-stressed units for defects that will adversely affect the execution and quality of the Work. Check location and condition of bearing surfaces. Verify that required inserts and anchors for connection to pre-stressed units have been installed. Do not proceed until unsatisfactory conditions are corrected.

B. Site Access: Provide suitable access to building, proper drainage, and firm, level bearing for hauling and erection equipment to operate under their own power.

3.02 PREPARATION

A. Surface Preparation: Thoroughly clean surfaces of adjoining construction of loose and foreign matter.

B. Place and accurate align anchor bolts, plates or dowels in column footings, grade beams and other field placed support members

3.03 INSTALLATION

A. Install pre-stressed units in their designed positions and in accordance with the manufacturer's approved shop drawings and instructions.
   1. Adjust units to be exposed in the finished work as required to comply with allowable tolerance.

B. Securely fasten pre-stressed units in place.
   1. Field Welding: Unless otherwise indicated, comply with the requirements stated in ES 3137.
   2. Grouting: Grout pre-stressed units with approved grout mix (mixes) and grout procedure complying with ES 2220.

C. Refinish damaged surfaces (if unit is not structurally damaged) to match adjacent areas.

D. Installation Tolerances: Shall comply with the requirements stated in ES 1496.

3.04 CLEANING

A. After installation, clean soiled and dirty concrete surfaces of pre- stressed units which will be exposed in the finished Work with detergent and water, using fiber brush and sponge. Immediately rinse thoroughly with clean water.

3.05 INSPECTION AND ACCEPTANCE:

A. Final inspection and acceptance of erected precast pre-stressed concrete shall be made by Resident Engineer to verify conformance with drawings and specifications.

END OF SECTION

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DIVISION 04 – MASONRY

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SECTION 040513

MORTAR AND MASONRY GROUT

PART 1 GENERAL

1.01 REFERENCES

A. EBSC EN 6: Design of Masonry Structures.

B. ES 2147: Specification for Mortar for Masonry - Masonry Mortar.

C. ES 2174: Specification for Ready Mix Building Mortars.

D. ES 3088: Code of Practice for Use of Masonry - Part 3: Materials and Components, Design and Workmanship.

E. ES 2261: Specifications for Building Sands from Natural Sources.

F. ES 2176: Mortar Admixtures – Specification for Set Retarding Admixtures.

G. ES 2169: Specification for Low Heat Portland Cement.

H. ES 2171: Specification for Sulfate - Resisting Portland Cement.

I. ES 1177-2: Cement Part 2: Conformity Evaluation.

J. ES 2038: Masonry Cement Requirements and Inspection.

K. BS 1014: Specification for Pigments for Portland cement and Portland Cement Products.

L. BS 890: Specification for Building Lime.

M. ASTM C 476:

1.02 SUBMITTALS

A. Product Data:
   1. Portland cement: Brand and manufacturer's name.
   2. Masonry cement: Brand and manufacturer's name.
   3. Lime: Brand and manufacturer's name.
   4. Sand: Location of pit, name of owner, and previous test data.
   5. Pigments: Brand and manufacturer's name.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in a manner which will insure the preservation of their quality and fitness for the Work.

B. Store cement and lime on raised platforms under waterproof, well ventilated cover.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement: Shall comply with:
   1. ES 2169: For low heat Portland cement.
   2. ES 2171: For sulfate - resisting Portland cement.
   3. Conformity Evaluation: Comply with the requirements of ES 1177-2.

B. Masonry Cement: Comply with ES 2038.

C. Hydrated Lime: Hydrated lime shall comply with the requirements of BS 890.

D. Quick Lime: Quick lime shall comply with the requirements of BS 890.

E. Sand: Comply with the requirements of ES 2261 for mortar and grout.

F. Pigments: Comply with BS 1014.

G. Water: Clean and free of deleterious amounts of acids, alkalis, and organic materials.

2.02 MIXES

A. Mortar mixes: Unless indicated in the Contract Documents, the mortar type and its proportions by volume shall comply with the requirements of EBSC EN 6, ES 2147, ES 2174, or ES 3088 as appropriate.

B. Grout: Comply with ASTM C 476. If grout types are not indicated on Drawings, furnish type (fine or coarse) most suitable for the particular job conditions to completely fill cavities and embed reinforcement and other built-in items.

C. Mortar Admixtures: As indicated in the Contract Documents. If not comply with applicable Referenced Standards.
   1. Comply with ES 2176 for set retarding admixtures.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Sections of Specifications which require mortar and masonry grout.

3.02 MORTAR SCHEDULE

A. The mortar schedule shall be as indicated in the Contract Documents. Where mortar types are not indicated in the Contract Documents or specified, comply with the requirements of applicable Referenced Standards and/or use the following types [refer Table 1] as specified in ES 3088 as appropriate:
   1. About one volume of binder is needed for three volumes of sand to give a workable mix but cement mortar of this kind is stronger than is necessary for most uses. For weaker mortars, lime or plasticizers are needed to maintain workability.

2. The mortar given in Table 1 have been selected to provide the most suitable mortar that will be readily workable to allow the bricklayer or block layer to produce satisfactory work at economic rate, be sufficiently durable and be able to assist in accommodating the strains arising from minor movements within the wall.
3. The mean water demand per 50 kg of cement shall be complied as per the requirements of ES 3088.

Table 1: Mortar mixes (type and proportion by volume)

		Types of Mortar		
		Cement:lime:sand	Air entrained mixes (see note 2)	
			Masonry cement:sand	Cement:sand with plasticizer
		Proportions by volume (see note 1)	Proportions by volume	Proportions by volume
↑ Increasing strength and improving durability	↓ Increasing ability to accommodate movements due to temperature and moisture changes	1: 0 to ¼ : 3		
		1 : ½ : 4 to 4 ½	1 : 2 ½ to 3 ½	1 : 3 to 4
		1 : 1 : 5 to 6	1 : 4 to 5	1 : 5 to 6
		1 : 2 : 8 to 9	1 : 5 ½ to 6 ½	1 : 7 to 8
		1 : 3 : 10 to 12	1 : 6 ½ to 7	1 : 8
Direction of change in properties is shown by the arrows.		Increasing resistance to frost attack during construction---------- →		
		Improvement in adhesion and consequent resistance to rain penetration ←		
Note 1: The proportions are based on dry hydrated lime. The proportion of lime by volume may be increased by 50 % (V/V) in order to obtain workability.				
Note 2: At the discretion of the designer, air entraining admixtures may be added to lime:sand mixes to improve their early frost resistance.				

END OF SECTION

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Ministry of Construction

SECTION 042000

UNIT MASONRY

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Mortar and Masonry Grout: Section 040513.

1.02 REFERENCES

A. EBSC EN 6: Design of Masonry Structures.

B. ES 3493: Compressed Earth blocks – Technical Specifications for Ordinary Compressed Earth Block Masonry.

C. ES 3494: Compressed Earth blocks – Technical Specifications for Facing Compressed Earth Block Masonry.

D. ES 3495: Compressed Earth blocks – Code of Practice for the Production of Compressed Earth Blocks.

E. ES 3496: Compressed Earth blocks – Code of Practice for the Preparation of Compressed Earth Mortars.

F. ES 3497: Compressed Earth blocks – Code of Practice for the Assembly of Compressed Earth Block Masonry.

G. ES 3088: Code of Practice for Use of Masonry - Part 3: Materials and Components, Design and Workmanship.

H. ES 2014: Masonry Part 1: Design and Construction.

I. ES 2016: Masonry Building of Prefabricated Brickwork Component.

J. ES 2036: Design and Installation of Masonry Cladding on Supports.

K. ES 2037: Reinforced Masonry Design and Construction.

L. ES 2269: Specification for Clay Bricks.

M. ES 2177: Specification for Masonry Cement.

N. ES 596: Specification for Concrete Masonry Units.

O. ES 2243: Specification for Masonry Units - Part 2: Calcium Silicate Masonry Units.

P. ES 2305: Specification for Masonry Units - Part 3: Aggregate Concrete Masonry Units (Dense And Light-Weight Aggregates).

Q. ES 3086: Code of Practice for Use of Masonry - Part 1: Structural Use of Unreinforced Masonry.

R. ES 3087: Code Of Practice for the Use of Masonry - Part 2: Structural Use of Reinforced and Pre-stressed Masonry.

S. ES 3171: Specification For Masonry Units - Part 4: Autoclaved Aerated Concrete Masonry Units.

T. ES 3173: Specification for Ancillary Components For Masonry - Part 1: Ties, Tension Straps, Hangers And Brackets.

U. ES 3174: Specification for Ancillary Components for Masonry - Part 2: Lintels.

V. ES 3175: Specification for Ancillary Components for Masonry - Part 3: Bed Joint Reinforcement of Steel Meshwork.

W. ES 3272: EUROCODE 6: Design Of Masonry Structures - Part 1-1: General Rules For Buildings - Rules for Reinforced and Unreinforced Masonry - (Together With United Kingdom National Application Document).

X. ES 3147: Code of Practice for Cleaning and Surface Repair of Buildings – Part 1: Cleaning of Natural Stones, Bricks, Terracotta and Concrete.

Y. ES 3148: Code of Practice for Cleaning and Surface Repair of Buildings – Part 2: Surface Repair of Natural Stones, Bricks and Terracotta.

Z. BS 1014: Specification for Pigments for Portland cement and Portland Cement Products.

1.03 DEFINITIONS

A. The terms in this Section of Specifications shall comply with the definitions stated in ES 3088 and the following:
   1. Masonry: Assemblage of units jointed with mortar.
   2. Masonry unit: Brick or block.
   3. Capping: Unit or assemblage placed at the top of the wall that does not shed rainwater from the top of the wall clear of all exposed surfaces of the walling beneath.
   4. Coping: Unit or assemblage placed at the top of the wall and designed to shed rainwater from the top of the wall clear of all exposed faces of the walling it is intended to protect.
   5. Cavity wall: Two parallel single leaf walls, usually at least 50mm apart and effectively tied together with wall ties.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Special masonry shapes.
   2. Drawings, showing reinforcement, applicable dimensions and methods of hanging soffit or lintel masonry and reinforcing masonry for embedment of anchors for hung fixtures.

3. Concrete masonry units for typical window and door openings, and, for special conditions as affected by structural conditions.

B. Product Data:
   1. Mortar:
      a. Portland cement: Brand and manufacturer's name.
      b. Masonry Cement: Brand and manufacturer's name.
      c. Lime: Brand and manufacturer's name.
      d. Sand: Location of pit, name of owner, and previous test data.
      e. Color Pigments: Brand and manufacturer's name.

   2. Masonry Wall Reinforcement: Catalog sheets and specifications.

C. Samples:
   1. Brick: Comply with the requirements of ES 2269 for the number of bricks required for sample and sampling procedure for testing dimensional checks, determination of soluble salt content, determination of comprehensive strength, and determination of water absorption.
   2. Concrete Masonry Units: Comply with the requirements of ES 596.
   3. Masonry Wall Reinforcement: As required by the Engineer.

D. Quality Control Submittals:
   1. Test Reports:
      a. Brick: At the written request of the Engineer, submit certified test reports for each type of brick showing compressive strength, water absorption, soluble salt content and dimensions.
      b. Concrete Masonry Units: Submit certified test reports for each size showing compressive strength, transverse strength, drying shrinkage strength and dimensions.

1.05 QUALITY ASSURANCE

A. Pre-Installation Meeting:
   1. After approval of all submittals and within a reasonable time prior to the start of Work, a meeting will be held at the Site for the purpose of reviewing mortar, reviewing the Contract Documents, and discussing the requirements and procedures for the Work.
   2. The following persons must attend the meeting:
      a. The Contractor, the person supervising this phase of the Work, the Engineer's Representative, and the Design Structural Engineer.
      b. The Engineer's Representative will provide a meeting agenda and administer the meeting

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: The handling and site storage of materials and components shall comply with the requirements of ES 3088.
   1. Masonry units:
      a. Unload and handle masonry units with care to minimize soiling, chipping and breakage.
      b. Do not stack units directly on the ground. Store them in stable stacks on a prepared hard-standing area. Protect the stacks from rain and frost, and from

soiling from ground and passing traffic. Protect the bottom of the stack from becoming wet from ground moisture.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless indicated in the Contract Documents, each type of masonry units shall comply with the geometrical, comprehensive strength and other necessary requirements of EBSC EN 6 and relevant Referenced Standards specified hereunder in PART 2 'PRODUCT'.

2.02 COMPRESSED EARTH BLOCK MASONRY UNITS

A. Ordinary and facing compressed earth block: Comply with ES 3495.

2.03 CLAY MASONRY UNITS

A. Clay brick: Shall comply with ES 2269.
   1. Size, Color, and Texture: For the existing adjacent brickwork construction, match existing adjacent brickwork as practicable as possible unless specified otherwise.

2.04 CALCIUM SILICATE MASONRY UNITS

A. Shall comply with ES 2243.

2.05 CONCRETE MASONRY UNITS

A. Shall comply with ES 596.

B. Comply with ES 3171 for autoclaved aerated concrete masonry units.

C. Aggregate concrete masonry units:
   1. Comply with ES 2305 for both dense and light-weight aggregates.

2.07 PRECAST CONCRETE LINTELS

A. Lintels: Comply with ES 3174.

B. Finishes:
   1. Surfaces not exposed to view: Smooth form finish.
   2. Interior surfaces exposed to view: Grout cleaned finish or match the finish of adjacent concrete masonry units.
   3. Exterior surfaces exposed to view: Smooth rubbed finish.
   4. Surfaces to be plastered: Roughened surface which will afford firm plaster bond.

C. Length: As required or shown on the Drawings.

2.08 MORTAR AND GROUT

A. Mortar and grout: Shall comply with the requirements of Section 040513 except for mortar for earth block.

B. Mortar for compressed earth block: Comply with ES 3496.

C. Pigments:
   1. Pigments should conform to BS 1014.

2.09 REINFORCEMENT

A. Reinforcement for structural use should follow the recommendations of ES 3087. Reinforcement for non-structural use, example for crack control, should be of a type approved by the Engineer.

2.10 ACCESSORIES

A. Bed joint reinforcement of steel meshwork:
   1. Comply with ES 3175.

B. Ties, tension straps, hangers and brackets:
   1. Comply with ES 3173.

2.11 DUMP-PROOF COURSES

A. Comply with the materials stated in ES 3088.

2.12 SILLS

A. Comply with the materials stated in ES 3088.

2.13 COPINGS

A. Comply with the materials stated in ES 3088.

2.14 FLASHINGS

A. Comply with the materials stated in ES 3088.

PART 3 EXECUTION

3.01 PREPARATION

A. Setting out: Comply with ES 3088 for setting out of masonry and the following:
   1. Lay out walls and partitions with one course of unit masonry, or other suitable means, to define the spaces, locations of doors and other openings, and to serve as a guide for other trades in the installation of conduits, pipes, etc.
   2. Care should be taken to reduce the cutting of masonry units to a minimum and to avoid irregular or broken bond, particularly at openings or in piers.
   3. A full masonry unit should be positioned directly beneath a lintel bearing.

B. Allow other trades sufficient opportunity to install built-in work before proceeding with the walls and partitions. Do not cover pipes, conduit, or ductwork in masonry until directed by the Engineer’s Representative.

C. Clean off supporting surface under first course of masonry just prior to laying the masonry units.

D. Protection:
   1. Protect face materials against staining.
   2. Protect newly laid masonry from exposure to precipitation, excessive drying, freezing, soiling, backfill, and other harmful elements.

3.02 INSTALLATION

A. The assembly of compressed earth block masonry shall comply with the ES 3497.

B. Install masonry units plumb and true to line with level courses accurately spaced. Install masonry units with appropriate masonry bond and joint finishes complying with the requirements of ES 3088.
   1. Brick masonry bond: English bond, Flemish bond, English garden-wall bond, Flemish garden-wall bond, Header bond or other as specified in the Contract Documents.
   2. Block masonry bond: Running or stretcher bond, thin stretcher bond, or off-center running bond or other as specified in the Contract Documents.
   3. Joint finishes: Flush, struck or weathered, bucket handle (keyed), or recessed.
   4. As per the requirements of the contract Documents, install masonry units in existing masonry bond pattern. Match existing unit masonry coursing and joints.
   5. Take special care when laying masonry units to be left exposed, or thin set tile will be applied. Surface plane tolerance for such Work shall comply with the referenced standard in all directions.

C. Adjust units to final position while mortar is soft and plastic. Remove units disturbed after mortar has stiffened; clean units and joints of mortar and re-lay in fresh mortar.

D. Lay only dry concrete masonry units.

E. Where cutting of masonry units is necessary, cut with a power saw. Lay out Work to avoid use of less than half-size units.

F. Lay hollow units with full mortar coverage on horizontal and vertical face shell surfaces. Bed webs in mortar in starting course on footings and foundation walls, in all courses of piers, columns and pilasters, where adjacent to cells or cavities to be reinforced or filled with concrete or mortar, and within of each side of openings.

G. Lay solid units with full mortar coverage on horizontal and vertical joint surfaces.

H. Cavity Wall Construction: Build a cavity wall complying with the requirements of ES 3088. Keep cavities clean of mortar droppings.

3.03 JOINTS

A. Construct uniform mortar joints, normally 10 mm thick unless otherwise indicated.

B. Strike joints flush in surfaces to be plastered, stucco, or covered with other masonry or other surface applied finish.

C. Cut joints flush and tool slightly concave on both sides of other walls and partitions.

3.04 HORIZONTAL JOINT REINFORCEMENT

A. Unless otherwise shown on the Drawings, reinforce horizontal joints with continuous masonry wall reinforcement spaced every 40 cm vertically except as follows:
   1. Space 20 cm vertically in parapet walls.
   2. Also reinforce horizontal joints immediately above and below openings in both directions.

B. Do not bridge control joints or expansion joints with reinforcement.

C. Lap ends of adjoining strips of reinforcement 6 inches or more.

D. Install factory fabricated corner and tee sections at corners and wall intersections respectively.

3.05 TYING ADJACENT WYTHES

A. Unless otherwise shown on Drawings, tie adjacent Wythe of masonry walls together with continuous masonry wall reinforcement spaced vertically not more than 40 cm on center. Install reinforcement as specified under Horizontal Joint Reinforcement part above.

3.06 BONDING WITH MASONRY

A. Lay masonry units in masonry bond for the following:
   1. External corners of partitions and walls.
   2. Pilasters, piers, and columns.
   3. Intersections of walls and partitions with a door opening within one foot of intersection. Fill cells between the intersection and the door frame with mortar to the full height of the door.

3.07 TYING INTERSECTING WALLS AND PARTITIONS

A. Except where masonry bond is specified, terminate abutting walls and partitions flush against the face of the abutted walls. Tie intersections at every second course as follows:
   1. Load-Bearing Walls: Install tie-bars. Embed bent ends in cells filled with mortar. Install pieces of metal lath under the cells to support the mortar fillings.
   2. Non-Load-Bearing Walls: Install ties of masonry wall reinforcement tee sections or strips of hardware cloth embedded in mortar.
      a. Center standard length masonry wall reinforcement tee sections on the walls.

B. Fill vertical joint at intersection of abutted walls and partitions solid with mortar. If a control joint is located at the intersection, rake out both sides of joint to a depth of 1 cm.

3.08 ANCHORING

A. Anchor walls adjoining or intersecting structural framing, and dependent upon structural framing for lateral support, to structural members with flexible anchors secured to structural members.
   1. Space flexible anchors 40 cm on center, unless otherwise shown on the Drawings.

3.09 CONTROL AND EXPANSION JOINTS

A. Install control and expansion joints at locations indicated. Keep joints free of mortar and debris.

3.10 WEEP HOLES

A. Unless otherwise shown on the Drawings, form weep holes in exterior Wythe of cavity walls by leaving head joint free and clean of mortar, and raking out bed joint at weep hole. Form weep holes approximately 60 cm on center along bottom of cavity over foundations, bond beams, through wall flashings, and other water-stops in the wall. Keep weep holes free of mortar droppings.

3.11 BUILT-IN WORK

A. Avoid cutting and patching.

B. Build-in bolts, anchors, nailing blocks, inserts, frames, vents, flashings, conduit and other items as masonry work progresses.

C. Fit masonry units closely around built-in items. Fill voids around built-in items with mortar for anchorage. Solidly fill space between masonry and metal frames with mortar.

D. Unless otherwise shown on the Drawings, construct 0.5 cm to 1 cm wide open joint around outside perimeter of exterior door and window frames and other framed exterior wall openings to receive sealant. Rake joints and tool smooth to a uniform depth of 0.5 cm.

E. Flashings: Clean contact surfaces and remove projections which might puncture the flashing. Place flashing on bed of mortar and cover with mortar. Seal joints with joint sealant.

3.12 LINTELS

A. Install lintels over openings in masonry. Center lintel over opening. Set in full bed of mortar under each end.

3.13 CLEANING AND MAINTENANCE

A. Clean the face of the units after completion of setting, pointing, and other Work liable to dust, rust and other stains, adhering mortar and other droppings complying with the requirements of ES 3148 and the followings
   1. Cut off mortar projections remaining from tooling joints and dry-brush masonry before the end of each day’s work.
   2. Clean brickwork with stiff brushes and water. If staining or soiling persists, as judged by the Engineer’s Representative and in accordance with the manufacturer’s instructions, re-clean with appropriate masonry cleaning agent until staining or soiling removed and cleaned.

B. Repair damaged masonry work and defective mortar in joints complying with the requirements of ES 3148.

3.14 PROTECTION

A. The finished works shall be properly protected from weather, subsequent building or other operations by complying with the requirements of ES 3088 and the following:
   1. Provide temporary support, as directed by the Engineer's Representative, for walls during construction to prevent damage by wind.
   2. Newly erected masonry should be protected by covering from the top of the wall with tarpaulins or other appropriate waterproof sheets in order to prevent the mortar being washed out of the joints by rain.

3.15 SCHEDULES FOR MASONRY UNITS

A. Unless shown otherwise on the Drawings, the choice of masonry units and mortar designations most appropriate for a particular situation as regard to durability shall comply with the requirements stated in ES 3088.
   1. The durability of masonry in finished construction is directly influenced by the masonry condition or situation to be constructed. Therefore, the quality of masonry units and appropriate mortar designations shall be selected with respect to the masonry condition or situation as per requirements of ES 3088 stated under workmanship section. Use appropriate kind of masonry units for:
      a. Low or high risk of situation with or without freezing.
      b. Low risk of situation, for example, low parapets, on some single-story buildings.
      c. High risk of situation, for example, where a capping only is provided for the masonry.
      d. Exposed exterior Works.
      e. Rendered exterior walls.
      f. Rendered parapets.
      g. With or without capping, copings and sills.
      h. Interior walls and inner leaves of cavity walls including wall backing.
      i. Interior bearing walls, pilasters, piers, columns, etc.

END OF SECTION

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SECTION 044000

STONE ASSEMBLIES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Mortar and Masonry Grout: Section 040513.

1.02 REFERENCES

A. EBSC EN 6: Design of Masonry Structures.

B. ES 2212: Specification for Cast Stone.

C. ES 3116: Specification for Reconstructed Stone Masonry Units.

D. ES 3147: Code of Practice for Cleaning and Surface Repair of Buildings – Part 1: Cleaning of Natural Stones, Bricks, Terracotta and Concrete.

E. ES 3148: Code of Practice for Cleaning and Surface Repair of Buildings – Part 2: Surface Repair of Natural Stones, Bricks and Terracotta.

F. BS 5390: Code of Practice for Stone Masonry.

G. BS 8298: Code of Practice for Design and Installation of Natural Stone Cladding and Lining.

H. BS 1014: Specification for Pigments for Portland cement and Portland Cement Products.

1.03 DEFINITIONS

A. The definition of the terms in this section shall comply with the definitions stated in BS 5390 and the followings:
   1. Ashlar:
      a. A square-hewn stone or masonry consisting of blocks of stone, finely square-dressed to give dimensions and laid in courses with thin joints.

   2. Cast stone: Any material manufactured with aggregate and cementitious binder, intended to resemble in appearance, and which may be used in a similar way to, natural stone.
   3. Course: A continuous layer of stones of uniform height in a wall, including the bed mortar.
   4. Pointing: The finishing of joints in mortar as the work proceeds or the filling with mortar of the joints in a wall from which the bedding or joining mortar has been raked out.
   5. Hewing: Hand working of stone.
   6. Fixings: A general term for the various types of cramp, dowel or metal corbel used to fix stone permanently to a backing.

1.04 SUBMITTALS

A. Shop Drawings: Setting and detail drawings showing dimensions, sections, jointing, anchoring and setting number of each stone.

B. Product Data: Suppliers' catalog sheets and specifications for stone units; and catalog sheets, specifications, and installation instructions for accessories.

C. Samples:
   1. Stone: Each kind and type specified, 30cm x 30cm x 2.5cm, showing quality, color range and veining, grain, and finish.
      a. Existing Stone: Where new stone is to match existing stone, submit cleaned samples of existing stone for comparison with new.

   2. Accessories: Each item and type specified.

D. Quality Control Submittals:
   1. Certificates:
      a. Qualifications: Statements certifying that the stone installer have the specified qualifications.
      b. Stone: Statement certifying that each kind and type of stone provided for this project meets the requirements of these specifications.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Installer: At least five years of experience specializing in installing cut stone.

B. Source Quality Control: Stone of a given color range and grain shall come from a single quarry.

C. Field Example: Prior to installation of rough stone, construct a wall panel at the site. When approved, the panel will be the standard of workmanship required for all stonework constructed of the same materials.
   1. Make panel 1.5m long by 1m high by full wall thickness, showing the approved color range, bond, mortar joints, exposed surface conditions, and workmanship.
   2. Do not start stonework until the example panel has been approved by the Engineer's Representative.
   3. Maintain approved example panel intact until all stonework has been installed and approved; then remove panel from the site.

D. Defects:
   1. Stoned obtained from quarry shall be checked for;
      a. Soundness.
      b. Durability.
      c. Free from vents, cracks, sand holes, discoloration or other defects that adversely affect strength or appearance.

   2. Do not use stone units with chipped arises, cracks, voids, stains, or other defects which will be visible in the finished Work.
   3. Do not patch or hide defects. Remove defective stone units from the Site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shall comply with the transport, storage and handling requirements of BS 5390.
   1. Store stone clear of ground that will prevent the leaching of soil salts into it, staining from moisture, and other damage.
   2. Handle stone in a manner that will prevent chipping, staining, and other damage. Use suitable lifting devices. Protect stone with suitable wood or other rigid cushioning materials.

1.07 PROJECT CONDITIONS

A. Environmental Requirements; Cold Weather Conditions:
   1. Maintain weather conditions for mortar and masonry for the required temperature by complying with the requirements of applicable Referenced Standards.

B. Existing Conditions: Take necessary field measurements of existing structures.

PART 2 PRODUCTS

2.01 GENERAL

a. The materials, components, accessories and fabrication for stone masonry units shall comply with the requirements of ES 2212 for cast stone, ES 3116 for reconstructed stone masonry units and BS 5390 for natural stone masonry units.
   1. Color: As specified in the Contract Documents.
   2. Finish: As specified in the Contract Documents.
   3. Grade: Free of cracks, seams, and starts which may impair structural integrity or function and/or as required by the Contract Documents.

b. The materials and components for stone cladding and lining shall comply with the requirements of BS 8298.

2.02 CAST STONE

A. Cast stone shall comply with the requirements of ES 2212.

2.03 RECONSTRUCTED STONE MASONRY UNITS

A. Comply with ES 3116.

2.04 NATTURAL STONE MASONRY UNITS

A. Igneous rocks:
   1. Granite.
   2. Basalt.
   3. Diorite.
   4. Serpentine.

B. Sedimentary rocks:
   1. Limestone.
   2. Sandstone.

C. Metamorphic rocks:
   1. Slate.
   2. Marble.

2.05 CLADDING STONE

A. The stones for cladding:
   1. Granites.
   2. Marbles and hard limestone.
   3. Slates and quartzite.
   4. Limestone and sandstones.

B. Color: As specified in the Contract Documents.

C. Size: The units should be worked to sizes indicated on the approved Drawings and be with recommended deviations.

D. Finish: Stone face finishes shall be as specified in the Contract Documents or the following:
   1. Granites: Polished, honed, axed, dolly pointed, flame texture or tooled.
   2. Marbles and hard limestone: Polished, eggshell or honed.
   3. Slate: Riven, flame textured, sawn or fine rubbed.
   4. Quartzite: Riven.
   5. Limestone and sandstones: Fine rubbed, tooled, sawn or riven.

E. Density of cladding stone:
   1. The maximum masses per square meter of cladding stone shall comply with the requirements of BS 8298.

2.05 MORTAR AND GROUT

A. Shall comply with the requirements of Section 040513.

2.06 COMPONENTS

A. Cast stone blocks and cast stone lintels shall comply with the requirements stated in ES 2212.

2.07 ACCESSORIES

A. Metal dowels and fixings:
   1. Metal dowels and fixings should be non-corrodible, preferably of non-ferrous metal or stainless steel.
   2. Appropriate type of material for the specific purpose shall be selected complying with the requirements of the referenced standard.

B. Metal wall ties:
   1. Metal wall ties should be of copper, phosphor bronze, or stainless steel.

C. Stone Cleaner: Non-staining cleaning solution which will not harm stone or mortar.

2.08 FABRICATION

A. Cut stone to the required dimensions and profiles, with surfaces finished to true planes.
   1. Cut or drill to form chases, openings, reveals, reglets, and similar spaces and features shown and as required for contiguous work.

B. Tolerances: Stone shall be cut within the indicated tolerances for the specified finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive stone for defects that will adversely affect the execution and quality of the Work. Do not proceed until unsatisfactory conditions are corrected.
   1. Verify that required built-in anchorage items are installed in designed locations.
   2. Verify that required bituminous damp-proofing, if included in the Contract Documents, has been applied.

3.02 PREPARATION

A. Just prior to setting stone, clean surfaces that support the Work of this Section.

B. Clean stone before setting by scrubbing with fiber brushes, followed by a thorough drenching with clear water. Use only mild cleaning solutions that contain no harsh or caustic abrasives or fillers.

C. If stone is not wet at time of setting, drench or sponge stone with clean water except do not wet expansion joint or control joint surfaces that require sealant.

D. When no concrete beam or other building material is provided under stonework a minimum thickness of 50mm lean concrete shall be placed on the excavated bottom before application of mortar.

3.03 INSTALLATION

A. General: The installation of masonry units and wall cladding shall comply with the respective referenced standards.
   1. Comply with ES 2212 for cast stone installation.
   2. Comply with ES 3116 for the installation of reconstructed stone masonry units.
   3. Comply with BS 8298 for the installation of natural stone cladding and lining.
   4. Comply with BS 5390 for the installation of natural stone masonry units.

B. Install stone plumb and true to line in level courses, unless otherwise shown.
   1. To ensure that rough-faced stonework is erected plumb, temporary but rigid vertical forms or battens should be erected at the building angles about 30cm away from the wall face from which a constant distance should be maintained when forming the bed joints of the quoins. Lines should then be stretched either from the laid quoin stones or from the battens which will indicate the face of the bed joints in the intermediate walling.

C. Set stone in full mortar setting bed and completely fill joints, accessory sinkages, and lifting holes with mortar, except keep expansion joints, control joints, and other required cavities free of mortar.

D. Solidly build-in accessories, supports, and contiguous items of other trades unless otherwise shown or directed.

E. Set stone with appropriate joint width and beds, unless otherwise shown. If necessary, temporarily use wet wooden wedges for proper spacing.
   1. Tolerance: Comply with the requirements of referenced standards for maximum variation for joint width.

F. Ashlar:
   1. Check the blocks as delivered are of proper dimensions and will work-in satisfactorily.
   2. The positions of the main features, such as quoins, door jambs, etc., should be checked, and a gauge-lath then prepared and marked off, making allowance to the joints.
   3. Distribute the stones throughout the Work in such a manner as to avoid a mechanical or patterned effect.
      a. The thickness of the bedding and the width of the vertical joints should be not less than 5 mm.

G. Rubble:
   1. Trim rough irregularities as required for setting.
   2. Fill spaces between stones with spalls laid in mortar flush with surfaces of stonework.

H. After mortar has set "thumb-print" hard, rake out exposed joints with allowable depth. Brush face of joints clean. Remove wooden wedges when setting bed will maintain stone in position without movement

3.04 POINTING

A. Except where joints are to be pointed with sealant, wet the raked joints and point full with pointing mortar. Cut joints flush and neatly tool surface of joints slightly concave. Unless specified otherwise, finish joints that abut other masonry to match the joint finish of the adjacent masonry.

3.05 CLEANING AND MAINTENANCE

A. Clean the face of the units after completion of setting, pointing, and other Work liable to dust, rust and other stains, adhering mortar and other droppings complying with the requirements of ES 3148 and the following:
   1. Granite and marble: Smooth surface should be wiped down with a clean cloth or chamois leather, and tooled or textured granite surfaces brushed down with a bristle or soft non-ferrous wire mesh.
   2. Slate: Slate should be cleaned by washing with clean water.
   3. Limestone and sandstone: Any slurry protection of limestone should be scraped off the face of the stonework and either thoroughly washed with clean water or, in the case of hard stone, rubbed by hand with an abrasive block or by mechanical spinner.
      a. Do not use any acid bearing cleaner on limestone.

B. Repair damaged stonework and defective mortar in joints complying with the requirements of ES 3148 and the following:
   1. Defective mortar joints shall be repointed with a mortar similar to the originally used, and having a sufficiently high frost resistance.
   2. Repair decayed or damaged stonework as per the requirements of the referenced standard.

3.06 PROTECTION

A. Comply with the requirements of referenced Standards for the protection of materials and finished works on construction sites.

B. Protect face materials against staining. Remove misplaced mortar immediately.

C. Protect newly laid masonry from exposure to precipitation, excessive drying, freezing, soiling, backfill, and other harmful elements.

D. Cover top of walls with non-staining, waterproof, temporary covering when work is not in progress. Unless specified otherwise protective covering shall overhang each side of wall a minimum of 60cm and be securely anchored.

E. Protect sills, ledges, off-sets, and similar features from drippings and other damage during construction.

END OF SECTION

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DIVISION 05 – METALS

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Ministry of Construction

SECTION 051000

STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Anchor Bolts: Installed under Section 033000.

B. Loose Bearing Plates: Installed under Section 042000.

C. Loose Lintels: Installed under Section 042000.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Field Painting: Section 099101.

B. Cast-In-Place Concrete: Section 033000.

C. Mortar and Masonry Grout: Section 040513.

1.03 REFERENCES

A. EBSC EN 1993-1-1:2015: Design of Steel Structures – Part 1-1: General Rules and Rules for Buildings.

B. EBSC EN 1993-1-8:2015: Design of Steel Structures – Part 1-8 Design of Joints.

C. ES 2087: Execution of Steel Structures – Part 1: General Rules and Rules for Buildings.

D. ES 3139: Structural Use of Aluminum – Part 1. Code of Practice for Design.

E. ES 2030: Tolerances in Building – Prefabricated Steel Components.

F. ES ISO 14555: Welding – Arc Stud Welding of Metallic Materials.

G. ES ISO 9606-(1-5): Approval Testing of Welders – Fusion Welding.

H. ES ISO 15607: Specification and Qualification of Welding Procedures for Metallic Materials – General Rules.

I. ES ISO 1461: Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles – Specifications and Test Methods.

J. ES 912: Metal Finishing – Preparation and Pretreatment of Surfaces. Method Selection Guide.

K. BS 8118-2: Structural Use of Aluminum – Part 2. Specifications for Materials, Workmanship and Protection.

L. ES ISO 262: General Purpose Metric Screw Threads – Selected Sizes for Screws, Bolts, and Nuts.

1.04 DESIGN REQUIREMENTS

A. Design: Unless other requirements stated in the Contract Documents, design details and connections shall be in accordance with requirements of EBSC EN 1993-1-1:2015 and EBSC EN 1993-1-8:2015 for steel structures and ES 3139 for aluminum structures to resist forces, moments, shears and allow for movements indicated.
   1. Connections: Design and detail all connections for each member size, metal grade and connection type to resist the loads and reactions indicated on the Drawings. Use details consistent with the details shown on the Drawings, supplementing where necessary. The details shown on the Drawings are conceptual and do not indicate the required weld sizes or number of bolts unless specifically noted. Use the requirements of relevant Standards and/or rational engineering design and standard practice as appropriate in detailing, accounting for all loads and eccentricities in both the connection and the members. Promptly notify the Engineer of any location where the connection design criteria is not clearly indicated. The design of all connections is subject to the review and acceptance of the Engineer. Submit structural calculations prepared and sealed by a qualified engineer registered in Ethiopia where the project is located. Submit calculations for review before preparation of detail drawings.

B. Shop connections: Unless otherwise indicated, all shop connections shall be welded or high strength bolted. Field connections required to be welded or fully-tensioned high-strength bolted shall meet the same requirements when fabricated in the shop.

C. Field connections:
   1. Unless specified otherwise, the following field connections shall be welded or fully-tensioned high-strength bolted as shown or noted on the Drawings:
      a. Column splices.
      b. Roof truss splices.
      c. Column bracing.
      d. Connections for supports of machinery.
      e. All connections of trusses to columns.
      f. All connections of eave struts, eave purlins, first interior purlins, ridge beams, and ridge purlins to rigid frames and trusses.

   2. All other bolted field connections need only be tightened to the snug tight condition.
   3. When metal members of any cross section are to be spliced by welding in the field, a detailed welding procedure shall be submitted to the Engineer for approval. The procedure shall be detailed on shop drawings, submitted and approved prior to the fabrication of structural metal. The detailed field welding procedure shall include the method of supporting members during welding. All field welded splices shall be subject to applicable testing as per the requirements, as determined by the Engineer. Field splice locations, when specifically shown on Contract Documents, shall not be relocated nor shall splices be added without written approval of the Engineer.

D. Standard beam connections:
   1. Unless otherwise shown on the Drawings or required in the Specifications, all beam connections shall be framed in accordance with the requirements of applicable

Referenced Standards, with sizes and lengths of angles and welds and with fastener spacing as shown therein.

2. Standard beam connections shown on the Drawings shall be fabricated as detailed. Substitutions will not be approved.

E. Special beam connections:
   1. Where special conditions make it impracticable to provide connections complying with Paragraphs A thru D, and no details for such connections are shown on the Drawings, special connections shall be used. Such special connections shall, in general, comply with the provisions of applicable Referenced Standards.
   2. Typical details of proposed special connections shall be shown on the job standards.
   3. Special connections shown on the Drawings shall be fabricated as detailed. Substitutions will not be approved.

1.05 SUBMITTALS

A. Shop drawings: Submit shop drawings for all structural metal required by the Contract Documents. Machine-duplicated copies of Contract Drawings will not be accepted as shop drawings. Shop drawings shall be standard size sheets, except that erection drawings may be larger. The margin line from edge of sheet. The location and its contents, (e.g. fabricator's name, address, and telephone number) of the title block shall be as per the standard. Failure to submit legible drawings of required size will be cause for their disapproval without review. If the drawings are not prepared by a detailer under the direct control of the fabricator, the fabricator shall stamp each drawing and initial or sign the stamp to certify review and approval of the drawings, and conformance with the fabricator's shop practice and capability.
   1. Include the following in the initial submission:
      a. Drawings of proposed job standards for shop and field connections, including standard and special connections, complying with the requirements.
      b. Erection drawings indicating sizes, weights, and locations of all structural members.
      c. Anchor bolt and base plate plans.
      d. Others as required.

   2. Do not submit detail drawings, other than for anchor bolts and base plates, until after approval of the job standards and the erection drawings.
   3. Include the following in subsequent submissions:
      a. Index sheets and revised erection drawings to which erection marks have been added.
      b. Detail drawings of all structural members.
      c. Others as required.

   4. Indicate all required shop and field welds by Standard Welding Symbols in accordance with applicable Referenced Standards.
   5. Indicate shop painting requirements.
   6. Contract Drawings are not considered released for construction. Orders for materials may be placed only after approval of erection drawings or written approval of the Engineer.

B. Product data:
   1. Shop Paint: Manufacturer's name and printed product literature, including storage and application instructions.

C. Quality control submittals:
   1. Test reports: Submit 3 copies of each of the following:
      a. Metal manufacturer's mill test reports, covering physical and chemical tests, for all main material.
      b. Bolt manufacturer's test reports, covering physical and chemical tests, for each lot of high strength bolts supplied.
      c. Test reports shall be submitted no later than the end of the week covered by the reports except specified otherwise.

   2. Certificates: Whenever any structural metal items other than main members, such as anchor bolts, base plates and detail material, are supplied either from plant stock or from a warehouse, submit 3 copies of evidence of compliance of the material with the applicable requirements of this Specification. Such evidence shall consist of certification as to the source of the material and copies of purchase orders, manufacturer's certifications or, in the case of stock material, copies of the latest mill orders or purchase orders for routine replacement of such stock material.
   3. Fabricator's and Erector's Qualifications Data: Name and experience of fabricator and erector.
      a. Include a summary of their QC programs.

   4. Welding procedure specifications: Submit procedure specifications for each joint to be welded as per the requirements stated in ES ISO 15607.
   5. Welder's certification: Submit each welder's welding certification for each type weld and position before fabrication.

1.06 QUALITY ASSURANCE

A. Fabricator's qualifications: The fabricator of the structural metal shall be regularly engaged in the fabrication of structural metal, and shall be subject to the approval of the Engineer.

B. Erector's qualifications: The structural metal erector shall be regularly engaged in the erection of structural metal, and shall be subject to the approval of the Engineer.

C. Welders' qualifications: Welding shall be performed only by welders, welding operators, and the tackers who have good experience and qualification in the field.
   1. Comply with the requirements of ES ISO 9606-(1-5) for fusion welding.

D. Do not deviate from the requirements of the Contract Documents except where an option is specifically mentioned. The Engineer, however, may accept deviations proposed by the Contractor when it is deemed in the best interest of the Procuring Entity and if the deviations are consistent with sound and accepted engineering practice. Requests for deviations shall be made prior to the submission of shop drawings to preclude delay in the expeditious preparation and approval of the required shop drawings. In addition, design calculations or other data may be required to establish conformity of such deviations with the applicable Standards.

E. Provide certificate of Quality Compliance from steel fabricator upon completion of structural metal fabrication stating that the work has been designed and fabricated in accordance with the requirements of the contract documents.

F. Pre-Fabrication Meeting: A minimum of 14 days prior to the initial submission of shop drawings, as per the structural engineer, a meeting will be held at the Site for the purpose of reviewing the Contract Documents, and discussing the requirements and procedures for submittals and for the Work. The meeting will be conducted by the Engineer's Representative. The Contractor and the fabricator's project coordinator and certified welding inspector must attend the meeting.

1.07 INSPECTION

A. Quality control inspection: Maintain Quality Control (QC) inspection during the fabrication and erection of structural steel.
   1. Submit for approval a summary of the QC programs of the proposed fabricator and erector, including a list of their QC personnel and respective duties. Failure to obtain approval of the QC programs will result in rejection of the proposed fabricator and erector.
   2. At least one of the fabricators and one of the erector's QC personnel shall be a well experienced and have good knowledge in the field.
   3. The fabricator's welding inspector shall make minimum QC inspections as follows and shall prepare daily reports of such inspections:
      a. At the start of fabrication to review welder qualifications, welding procedure specifications and qualifications, welding equipment and consumables, structural steel identification and tracking procedures and to perform all other duties appropriate to startup of the specific project.
      b. Periodically during the preparation and fit up of material for groove welding.
      c. At all times that full penetration groove welding is being performed.
      d. As necessary to ensure that all welding related requirements of this section are being complied with.
      e. Minimum QC inspection time by the inspector shall be one-half day every other day that any welding related structural steel fabrication is being performed.

   4. The erector's welding inspector shall make minimum QC inspections as follows, and shall prepare daily reports of such inspections:
      a. Prior to commencement of field welding operations to review welder qualifications, welding procedure specifications and qualifications, welding equipment and consumables and to perform all other duties appropriate to startup of field welding for the specific project.
      b. Periodically during fit-up of material for full penetration groove welds.
      c. At all times that full penetration groove welding is being performed.
      d. As necessary to ensure that all welding related requirements of this section are being complied with.
      e. Minimum QC inspection time shall be one-half day on at least three separate days for every week that any structural metal field welding is being performed. This minimum time may be reduced if, in the opinion of the Engineer's Representative, such reduction is appropriate.

B. Quality Assurance (QA) inspection of structural steel fabrication and field welding and high-strength bolting may be made at the discretion of the Engineer. The qualification of welding procedures, welders, and tackers will be covered by such QA inspection. Representatives of the Engineer and/or designated inspection laboratory shall be given free and easy access to fabrication shop and field at all times that work is in progress.
   1. If QA inspection is made by the Procuring Entity, it shall not relieve the Contractor, fabricator, and erector of responsibility for their own QC programs.

2. When QA inspection is made by the Procuring Entity, schedule and perform the Work as required to minimize the cost to the Procuring Entity for QA inspection. When failure to schedule and perform the Work, or to coordinate with the QA inspectors, results in excessive QA inspection costs, the Procuring Entity will back charge such excess cost to the Contractor.
3. When QA inspection is made by the Procuring Entity, send 3 additional copies of required material certifications and mill test reports to the designated inspection laboratory.
4. Keep copies of the results of welder qualification test on file and make them available to the QA inspector upon request.
5. Do not ship structural steel, except anchor bolts and base plates, from the fabricating shop prior to QA inspection and approval by the Procuring Entity or designated inspection laboratory, unless such inspection is waived by the Engineer. A waiver of prior QA inspection and approval shall not reduce the Contractor's responsibility to provide structural steel in conformance with the Contract Documents.

1.08 WELDING PROCESSES

A. Appropriate welding processes shall be carried out as indicated or complying with the requirements of the Referenced Standards.
   1. Comply with ES 2087 for steel welding process.

1.09 WELDING PROCEDURE QUALIFICATION

A. Except specified in the Contract Documents otherwise comply with the general rules of ES ISO 15607 for qualifications of welding procedures for all metallic materials.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver anchor bolts and other devices which are to be embedded in Cast-In-Place Concrete or Masonry construction, for anchorage of structural metal, one week prior to the start of that Work, unless otherwise required.

B. Handling:
   1. Fabricated parts shall be handled and stacked in such a way that permanent damage is not caused to the components.

C. Receiving shop paint: Receive paint in original, unopened containers bearing paint manufacturer's printed label.
   1. Label shall show manufacturer's name, trade name of paint, shelf life, and date of manufacture.

D. Protection:
   1. Upon delivery to the site, promptly cover and protect steel items (which are not required to receive shop paint) from rusting.
   2. Store shop paint in accordance with paint manufacturer's printed instructions.

1.11 ENVIRONMENTAL REQUIREMENTS FOR SHOP PAINTING

A. Comply with the weather condition requirements of applicable Referenced Standards for the application of paint unless otherwise stated in the paint manufacturer's printed directions.

1.12 MINIMUM SHOP FACILITIES FOR TRUSS FABRICATION

A. Except specified otherwise the following requirements shall be maintained as required by the Engineer considering the project complexity and safety.
   1. The fabricator shall possess sufficient lifting capacity, physical plant and equipment for the fabrication and painting of structural metal trusses. The cranes in each working area shall have a combined rated capacity equal to the lifting weight of the heaviest assembly fabricated for shipment. A preliminary physical plant inspection will be made by the Engineer's Representative to verify compliance.
   2. Spreader beams, or multiple cranes, shall be provided for lifting long slender assemblies to prevent overstress and distortion from handling.
   3. The fabricator shall be responsible for the proper preparation of groove joints to be welded in the field. The joints shall be prepared and assembled in the shop to insure that proper joint alignment and fit up is present at each joint when the correct camber is in the assembled pieces.
   4. When truss members of any cross section are to be spliced by welding in the field, a detailed welding procedure shall be submitted to the Engineer for approval. The procedure shall be detailed on shop drawings, submitted and approved prior to the fabrication of structural metal. The detailed field welding procedure shall include the method of supporting members during welding. Field splice locations, when specifically shown on Contract Documents, shall not be relocated nor shall splices be added without written approval of the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural Steel: Comply with the requirements of EBSC EN 1993-1-1:2015 and EBSC EN 1993-1-8:2015, except as specified or shown otherwise.

B. Structural Aluminum: Comply with the requirements of ES 3139 or BS 8118-2 as appropriate, except as specified or shown otherwise.

C. Steel for anchor bolts, tie rods, sag rods, and other detail material not proportioned for calculated stress: Comply with the requirements of applicable Referenced Standards.

D. Steel for shims and fillers: Comply with the requirements of applicable Referenced Standards.

E. Exterior Lintels: Comply with the requirements of applicable Referenced Standards.

F. High-strength threaded fasteners (high-strength bolts): Heavy hexagon structural bolts, nuts, and hardened washers and shall comply with the requirements of applicable Referenced Standards.

G. Steel pipe: Comply with the requirements of applicable Referenced Standards.

H. Steel structural tubing: Comply with the requirements of applicable Referenced Standards.

I. Welding Consumables:
   1. General:
      a. All welding consumables used for steel welding processes shall comply with the requirements of EBSC EN 1993-1-8.
      b. All welding consumables used for aluminum welding processes shall comply with the requirements of BS 8118-2.

J. Steel Studs: Comply with the requirements of applicable Referenced Standards.

K. Cold galvanizing compound: As indicated in the Contract Documents. If not, use single component compound giving 93 percent pure zinc in the dried film, and meeting the requirements of applicable Referenced Standards.

L. Shop paint (general): Steel primer:
   1. Comply with the requirements of applicable Referenced Standards.

M. Shop paint for galvanized steel:
   1. Comply with the requirements of applicable Referenced Standards

N. Shop paint for steel to receive sprayed-on fireproofing: Primer paint, if any, recommended by the manufacturer of the fireproofing material approved for use on this Project.

O. Shop paint for exterior equipment supports (high-ratio water based zinc silicate): Steel primer:
   1. Comply with the requirements of applicable Referenced Standards.

P. Bedding mortar:
   1. Cement Grout:
      a. Comply with the requirements stated in Section 040513.

   2. Shrink-resistant grout (ferrous): Factory-packaged, non-catalyzed, ferrous aggregate mortar grouting compound:
      a. Comply with the requirements of applicable Referenced Standards.

   3. Shrink-resistant grout (non-staining): Factory-packaged, non-ferrous mortar grouting compound:
      a. Comply with the requirements of applicable Referenced Standards.

2.02 FABRICATION

A. Do not commence fabrication until the fabricator has been approved and the fabrication schedule has been coordinated with the designated Quality Assurance inspection agency (independent inspection laboratory or the Procuring Entity).
   1. Give the Engineer's Representative one week advance notice of the commencement of fabrication.

B. Progress shop fabrication from "Approved" or "Approved as Noted" detail drawings only.
   1. When detail drawings are "Approved as Noted", progress fabrication in strict accordance with notes thereon.

2. Fabrication progressed from “disapproved” or “returned for correction” detail drawings will be rejected. The contractor shall have no claim against the Procuring Entity for any costs or delays due to rejection of items fabricated from “disapproved” or “returned for correction” detail drawings.

C. Finish column ends at base plates and at load carrying cap plates to a true plane square to the column, as per the required Standards.

D. Pipe and tube columns: Cap columns with a closure plate shop welded to the top of the columns to exclude water and foreign material from entering the column.

E. Loose lintels: Loose lintels bearing on masonry or concrete shall have a minimum end bearing length of 15 cm at each end, unless otherwise noted.

F. Make provision for connections of other Work, including all cutting and punching of structural members where required by the Drawings, or for which information is furnished prior to approval of the shop drawings.

G. Weld and inspect steel studs shall be in accordance with the requirements of applicable Referenced Standards.

H. Remove extension bars or run-off plates upon the completion and cooling of groove welds. Grind the ends of the welds smooth and flush with the edges of the abutting parts.

I. Remove tack welds not incorporated into the final weld, and temporary welds. Grind affected surfaces smooth and flush.

J. Detail all fillet welded joints so as to permit the welding electrode or wire to be positioned at a minimum angle of 30 degrees from the face of any material upon which weld metal is to be deposited.

K. Prepare material in accordance with the requirements of applicable Referenced Standards. Do not use gas or air carbon-arc cutting to cut or enlarge bolt holes.

2.03 GALVANIZING

A. Unless otherwise specified or noted, items indicated to be galvanized shall receive applicable coating by the hot-dip process, after fabrication, complying with the following:
   1. ES ISO 1461 for iron and steel articles.

2.04 SHOP PAINTING

A. Thoroughly clean all structural steel. Remove oil, grease, and similar contaminants in accordance with the requirements of ES 912. Remove loose mill scale, loose rust, weld slag and spatter, and other detrimental material in accordance with the requirements of ES 912.
   1. Thoroughly clean structural steel receiving sprayed-on fireproofing in accordance with recommendations of the manufacturer of the fireproofing material approved for use on this Project.

B. Coordinate shop paint to be applied on steel receiving sprayed-on fireproofing with the manufacturer of the fireproofing material approved for use on this Project.

C. Galvanized Items:
   1. Galvanized items which are to be finish painted under Section 099101 shall be rinsed in hot alkali or in an acid solution and then in clear water.
   2. Welded and abraded galvanized surfaces shall be wire brushed and repaired with a coating of cold galvanizing compound applied in accordance with compound manufacturer's instructions.

D. Unless specified in the Contract Documents, apply one coat of shop paint to all steel surfaces except as follows:
   1. Do not paint steel members which do not need painting as indicated on the Drawings.
   2. Paint steel surfaces scheduled to be painted that are inaccessible after assembly, except surfaces in contact, with two coats of shop paint before assembly.
   3. Do not paint steel surfaces to be field welded, contact surfaces of high-strength bolted slip-critical connections, steel to be encased in cast-in-place concrete, steel receiving sprayed-on fireproofing, and the top flange of beams and girders in composite construction.
   4. Do not paint galvanized items which are not to be finish painted under Section 099101.

PART 3 EXECUTION

3.01 PREPARATION

A. Joint faces:
   1. Surface and edges shall be appropriate for the welding process and free from visible cracks and notches.
   2. Permitted deviations for prepared joint faces and fit up should be in accordance with the requirements of ES ISO 15607.
   3. Any surfaces to be welded shall be dry and free from any material that would adversely affect the quality of the welds impede the process of welding.
   4. Welding consumables showing signs of damage or deterioration shall be rejected.

B. Weather protection:
   1. Both the welder and the work shall be adequately protected against the direct effects of wind, rain and snow, particularly when using gas shielded welding processes.

3.01 ERECTION

A. Erect steel and aluminum in accordance with the ES 2087 and BS 8118-2 respectively, except as indicated otherwise specified.

B. Prepare and place shrink-resistant grout in accordance with grout manufacturer's printed instructions.
   1. Comply with manufacturer's instructions for preparation of surfaces in contact with the grout, and for curing and protection of the grout.

C. Install and inspect metal studs in accordance with the requirements of applicable Referenced Standards.

D. Remove extension bars and run-off plates upon the completion and cooling of groove welds. Grind the ends of the welds smooth and flush with the edges of the abutting parts.

E. Remove tack welds not incorporated into the final weld, and temporary welds. Grind affected surfaces smooth and flush.

F. Do not make corrections or alterations to fabricated steel without prior written approval by the Engineer's Representative.

3.02 SCHEDULE OF GALVANIZED STRUCTURAL STEEL

A. In addition to members indicated on the Drawings, hot-dip galvanize structural steel members as indicated below:
   1. All exterior exposed steel.
   2. All loose lintels in exterior walls.
   3. All framing supporting refrigerator/freezer equipment.
   4. Nuts, washers and the top 30 cm of exterior anchor bolts.

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DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

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SECTION 061000

ROUGH CARPENTRY

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Wood Trusses: Section 061753.

1.02 REFERENCES

A. EBSC EN 1995-1-1&2:2015: EBSC 5: Design of Timber Structures.

B. ES 1653: Workmanship on Building Sites. Code of Practice for Carpentry, Joinery and General Fixings.

C. ES 2084: Timber Structures – Structural Laminated Veneer Lumber – Requirements.

D. ES 1950: Structural Use of Timber. Code of Practice for the Preservative Treatment of Structural Timber.

E. ES 3277: Wood-Based Panels – Guidance on the Use of Load-Bearing Boards in Floors, Walls and Roofs.

F. ES 1641: Code of Practice for the Selection and Application of Particle Board, Oriented Strand Board (OSB), Cement Bonded Particle Board and Wood Fire Boards for Specific Purposes.

G. ES 1669: Code of Practice for Flooring of Timber, Timber Products and Wood Based Panel Products.

H. ES 3735-51: Glue for Wood Working – Specification.

I. ES 1270: Specification for Nails: Steel Nails.

J. BS 6100-4-4: Glossary of Building and Civil Engineering Terms. Part 4. Forest Products: Section 4.4 Carpentry and Joinery.

K. BS 6446: Specification for Manufacture of Glued Structural Components of Timber and Wood Based Panels.

1.03 DEFINITIONS

A. The terms under this Section shall comply with the definitions of BS 6100-4-4 including the following:
   1. Carpentry: Structural woodwork.
   2. Joinery: Assembly of worked timber components and panel products other than structural timber or cladding.
   3. Panel: Infilling of timber or wood based panel product to the space between framed members.

4. Laminated member: Solid member consisting of laminations connected together by nails, screws, bolts, connectors or adhesives.
5. Lamination: Process of bonding two or more layers of material.
6. Plate: Timber section used as a bearing for other members.
7. Wall plate: Structural member along the top of a wall or built into its length that distributes the forces from joists, rafters or roof trusses.
8. Blocking: Piece of timber fixed as a stiffener in angles, as in stairs, the heads of double hung sash windows, etc.
9. Ground: Small section, usually of timber, to which a skirting, architrave, opening lining, or similar is fixed and that may also be used as an edging for in situ plasterwork.
10. Opening lining: Lining at an opening.
11. Strutting: Member fixed between joists to provide lateral stability.
12. Backing: Material of construction of a wall or partition to which a facing is attached.

1.04 SUBMITTALS

A. product data:
   1. In addition to the requirements of submittals included in the Contract Documents, submit product data for approval by the Engineer before fabrication of materials and components indicating the following:
      a. Proposed type of timber, posts and laminated panel to be used.
      b. Proposed methods of impregnating timber & posts.
      c. Proposed place of fabrication of joinery.
      d. Additional necessary data as required by the Engineer.

B. Samples:
   1. In addition to the requirements of submittals included in the Contract Documents, submit samples of each type of Work in its component material, fabricated, assembled fixed and finished form and shall be produced as required for approval by the Engineer.

C. Quality control submittals:
   1. Certificates: Certification for the following wood treatments the whole or partly as required by the Engineer in addition to the requirements of submittals included in the Contract Documents.
      a. Dip Treatment: Certification by treatment plant stating chemical solutions, submersion period, and conformance with applicable standards.
      b. Pressure Treatment: Certification by treating plant stating chemicals and process used, net amount of chemical preservative retained, and conformance with specified standards.
      c. Water-Bourne Preservatives: Certified written statement that moisture content of treated materials was reduced to a maximum of 19 percent prior to shipment to Project site.
      d. Fire-Retardant Treatment: Certification by treating plant stating treated material complies with specified standards and treatment will not bleed through specified finishes.

1.05 QUALITY ASSURANCE

A. All materials and work thereafter shall in all respects, comply with the approved samples.

B. Samples shall be maintained and kept in their original condition until permission to remove them is granted by the Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: The delivery, storage and handling of materials shall comply with the requirements of ES 1653 including the following:
   1. General:
      a. Keep the site clean and tidy in order that the checking, handling and storage of materials and components can be carried out speedily and effectively.
      b. Program deliveries in accordance with the contract program, to reduce site storage to a minimum.
      c. Prepare storage arrangements for each item in advance of delivery.
      d. Unload straight into the designed storage space.

   2. Delivery:
      a. Carry out detail checks on delivery in accordance with the criteria set out in ES 1653. In particular:
         1) Check quantities during unloading.
         2) Check for damage to manufactured components during unloading.
         3) Assess moisture content during unloading on overall components.
            a) Keep materials dry during delivery.

      b. Reject items which fail on any aspect of condition or specification.

   3. Handling:
      a. When handling, ensure that the items are not subject to stresses greater than those that they will sustain once installed. In particular:
         1) Support flat, planer items at all corners.
         2) Support linear items adequately along their length to avoid undue ‘bow’.

   4. Storage:
      a. Provide storage in accordance with the criteria set out in ES 1653 to ensure that materials and components are maintained free from damage and are in conditions suitable for their specified moisture content.
         1) Store materials by complying with the minimum height (usually 15 cm) above ground surface.
         2) Stack materials and components in accordance with the methods stated in ES 1653, and provide air circulation between stacks.
         3) Protect against exposure to weather and contact with damp or wet surfaces.
         4) Cover stored materials and components with flexible or rigid sheets until ready for use for protection from moisture.
            a) Place and anchor cover in a manner that will provide good cross ventilation between the top of the items stored and the covering.

1.07 PROJECT CONDITIONS

A. Comply with the requirements of Contract Documents and relevant Referenced Standards.
   1. Correlate location of supporting members to allow proper attachment of other Work.

PART 2 PRODUCTS

2.01 TIMBER AND POST

A. General: Timber generally shall be to EBSC EN 1995-1-1&2:2015 and to be of mature growth, properly seasoned and to nominal sizes indicated including the following:
   1. All characteristics affecting the strength of the timber, i.e. arras, face, margin, splits, knots, edge knit, wane, defect ratio, slope of grain and the like shall comply with the requirements of relevant Referenced Standards.
   2. Timber ready for use shall be free from live borer, beetle, fungus or other insect attack. Timber for use or already used shall be removed and replaced if found defective and indication of their being attacked is evident or discovered.
   3. The moisture content of the timber is to be maintained at no more than the requirements stated in ES 1653.

B. Post truss and rafter: Truss and rafter shall be fabricated from eucalyptus or other equivalent posts complying with the requirements of relevant Referenced Standards.
   1. Members shall be spliced where necessary, securely nailed or bolted to each other and tied with mild steel bands at all splices and joints.
   2. Trusses and rafter shall be securely tied or bolted to the support as detailed or specified on Drawings. Where no details are shown the bottom members shall be securely tied using 6 or 8 mm diameter mild steel round bars embedded in concrete or masonry or welded to or tied around steel or timber supports.
   3. The member receiving purlins shall be uniform in elevation oil trusses and rafters along the length of the purlin. No truss or rafter member shall be notched to receive purlins. Notched member shall be removed and replaced unless approval is given to rectify by inserting wedges. Only sawn timber shall be used for wedging.

C. Sawn timber trusses and rafters: Trusses and rafters shall be fabricated from sawn timber complying with the requirements of relevant Referenced Standards.
   1. Truss members and rafters shall be overlapped or spliced at locations shown on Drawings. Changes of locations of splices and overlaps require prior approval.
   2. Truss members shall be securely nailed, screwed or bolted together as detailed on Drawings. The nails, bolts and screws to be used for the works shall comply with the requirements of relevant Referenced Standards.
   3. If additional ties to secure the members in position are shown on Drawings or instructed such ties shall be made in steel bands. Wedges and seats shall be in sawn timber and provided as detailed on Drawings or as instructed.
   4. The members receiving purlins shall be uniform in elevation on all trusses and rafters along the length of the purlin. No truss or rafter member shall be notched to receive purlins. Notched members shall be removed and replaced unless approval is given to rectify by inserting wedges.
   5. Trusses and rafters shall be securely tied or bolted to supports as detailed on Drawings. Where no details are shown, the bottom members shall he tied to the support using 6 or 8 mm diameter mild steel round bars embedded in concrete or masonry or welded to or tied around steel or timber posts.

D. Round timber purlins: Purlins shall be produced from eucalyptus or other equivalent timber complying with the requirements of relevant Referenced Standards.
   1. Purlins shall be securely nailed to trusses.

2. Purlins shall have uniform diameter throughout and shall be spliced at joints. The splices shall be 600 mm overlap if not shown on drawings. Splices shall be made at truss or rafter supports as far as possible.

E. Sawn timber purlins: Sawn timber purlins shall he produced from timber complying with the requirements of relevant Referenced Standards.
1. Purlins shall be securely nailed or bolted to trusses as detailed on drawings.
2. Purlins shall remain uniform in size throughout the whole length and spliced at joints. The splices shall be 600mm overlap if not indicated on drawings. Splices shall he made at truss or rafter supports wherever possible.

F. Post and timber uprights, beams and bracings: Post and timber uprights, beams and bracings shall comply with the requirements of relevant Referenced Standards.
1. Members shall be selected for uniformity of dimension and straightness. No spliced members shall be used for uprights. The splicing of beams and bracings shall he as detailed on drawings or as directed.
2. Posts, uprights, beams and bracings shall be embedded, tied, anchored, or bolted as shown in details. The bolts to be used shall comply with the requirements of relevant Referenced Standards.

G. Timber for joinery backing: Timber for the backing of joinery works like ceiling, soffits, cladding, doors, windows, built-in furniture shall comply with the requirements of relevant Referenced Standards.
1. Timber shall be milled if required by the nature of the joinery works.
2. Members shall be selected for uniformity of dimension and straightness.
3. Members shall be, placed set at spacing shown on Drawings and securely nailed or glued depending on the type of joinery.
4. Timber in one length shall be used for joinery backing. Where the joinery work requires shop drawing, the method of jointing shall be approved prior to production. Where cross members are placed, such cross members shall be securely nailed or glued together to ensure that no displacement occurs while the joinery facing is placed on the timber backing.

2.02 PLYWOOD

A. Sheathing and Subflooring:
1. Furnish appropriate veneered panels, with span ratings for the required thicknesses as indicated and complying with the requirements of relevant Referenced Standards.

B. Underlayment: Comply with the requirements of relevant Referenced Standards.
1. For use under resilient tile flooring and resilient sheet flooring: Sanded face.
2. For use under carpet and “liquid” flooring: Touch-sanded.

2.03 PARTICLEBOARD

A. Comply with the requirements of ES 1641.

2.04 HARDBOARD AND SOFTBOARD

A. Comply with the requirements of relevant Referenced Standards.

B. Hardboard and soft board shall be of specified thickness, selected for straight edges and consistency in surface grain.

C. The surfaces of hardboard and soft board shall be smooth or uniformly textured to receive paint finish.

2.05 GLUE

A. Comply with the requirements of ES 3735-51.

2.06 PRESERVATIVE TREATMENT

A. Treat timber where indicated and as specified. The preservative treatment for structural timber shall comply with the requirements of ES 1950.

B. Complete fabrication of items to be treated to the greatest extent possible prior to treatment. Where items must be cut after treatment, coat cut surfaces with two brush coat of the same chemical used for treatment or other solution recommended by ES 1950 Standards for the treatment.

C. Inspect timber after treating and drying. Discard warped or twisted items.

2.07 FIRE-RETARDANT TREATMENT

A. Furnish appropriate lumber where indicated, complying with applicable Referenced Standards for pressure impregnation with fire-retardant chemicals to achieve to the required flame-spread rating.

2.08 FRAMING HARDWARE

A. Fasteners and Anchoring Devices: Select and furnish items of type, size, style, grade, and class as required for secure installation of the Work. Unless shown or specified otherwise, comply with the following:
   1. Nails, Screws, Bolts/Nuts/Washers:
      a. Nails: Use nails of suitable length and appropriate nail for the different fixing conditions complying with the requirements and as set out in ES 1653.
      b. Screws: Select screw length according to the criteria applicable to nail length.
      c. Bolts/nuts/washers:

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Verification of Conditions: Examine substrate and supporting structure on which rough carpentry is to be installed for defects that will adversely affect the execution and quality of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Preparation: Comply with the requirements of ES 1653 for preparation before erection and installation. When materials and components are distributed to the work position:

1. Do not overload any part of the structure by stacking excessive quantities of materials or components.
2. Place any materials and components that are stored on upper floors near to the walls on which the joists bear and distribute the materials to avoid point loads.
3. Clean out all shavings, sawdust, offcuts and other rubbish from voids before these are close in, and as the work proceeds.
4. Treat all surfaces of preservative treated timber exposed in cutting, with two brush applied flood coats of the appropriate preservative.
5. Ensure that the moisture contents of the timber sections and components, when built into the work, do not exceed the moisture content requirements stated in ES 1653.

3.02 INSTALLATION - GENERAL

A. Install Work of nominal sizes indicated or of units built-up to dimensions indicated, on spacing shown. Unless otherwise indicated, comply with the requirements of ES 1653:2005. Construct required openings for installation of related work. Do not splice structural members between supports.

B. Install miscellaneous blocking and framing indicated and as required for attachment and support of facing materials, fixtures, specialty items, and trim.

C. Do not use units of material with defects which impair the quality of the Work and units which are too small to fabricate the Work with minimum joints or with optimum joint arrangement.

D. Install Work accurately to required lines and levels with members plumb and true, accurately cut and fitted and securely fastened. Closely fit rough carpentry to other associated construction.

E. Securely attach carpentry Work to substrates by anchoring and fastening as indicated or, if not indicated, as required by the referenced standards. Select fasteners of size that will not penetrate through 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. Set nail heads in exposed Work which is to be painted or stained and fill resulting holes.

F. Treated Wood: Apply two brush coats of treatment material to field cut surfaces where necessary.

G. Accuracy: Construct all Work square, true to level and in correct alignment within the required limit of deviation stated in ES 1653.

3.03 FIXING METHODS

A. Securely brace timber members or components temporarily during construction to hold them in position, to prevent displacement by wind or other forces and to prevent straining unfinished work.

B. Nailing: Anchor and nail members as indicated. If not indicated, comply with the requirements of ES 1653 for type of nails to be used, appropriate application and nail spacing.

C. Screwing and bolting: Comply with and follow the requirements of ES 1653.

D. Gluing: Follow the adhesive manufacturer's recommendations with respect to shelf life, mixing, environmental conditions for application and curing, moisture content of members and all other factors relevant to the proper use of adhesives.
   1. Ensure that the surface to be glued are freshly prepared, clean and free from dirt, dust, oil or other contamination likely to affect the performance of the adhesive, and that there is close contact of the surfaces over the area to be joined.
   2. Apply sufficient glue evenly over the surfaces to ensure that, after application of the bonding pressure, an unbroken glue line is obtained.

3.04 WOOD NAILERS, BLOCKING, AND GROUNDS

A. Install required items where indicated and where required for support, attachment or screeding of other Work. Form to shapes indicated or required. Coordinate locations and cut and shim as required to provide items at true and level planes to receive Work to be attached. Install closure strips for nailers at all edges.
   1. Attach to substrates as indicated; if not indicated, size and space fasteners as required to support applied loading. Maximum spacing of fasteners shall not exceed 40 cm. Unless otherwise shown on the Drawings, install and secure material to non-wood construction as follows:
      a. To Concrete: Attach material less than 2.5-1.25 cm thick with screws and non-ferrous metal expansion shields. Attach material 2.5-1.25 cm and thicker with machine bolts and non-ferrous metal compound type anchors.
      b. To Concrete Unit Masonry: Attach material to new masonry with annular ring nails driven into wall plugs where fastening occurs at joints of masonry or with special hardened steel masonry nails where fastening occurs in the masonry units. Attach material to existing masonry with machine screws and non-ferrous metal expansion shields where fastening occurs in solid portions of masonry. If fastening occurs at cells of masonry, secure material in place with toggle bolts.
      c. To Brick Masonry: Attach material to new masonry with annular ring nails driven into wall plugs. Attach material to existing masonry with machine screws and non-ferrous metal expansion shields.
      d. To Steel: Attach material with galvanized bolts and nuts or stainless steel machine screws tapped into the metal, as required by conditions.
      e. To Non-Ferrous Metal: Attach material with stainless steel or other approved non-ferrous metal bolts and nuts or self-tapping screws, as required by conditions.

   2. Counter-sink bolts and nuts flush with surfaces, unless otherwise shown. Build into masonry during installation of masonry Work. Where possible, anchor to formwork before concrete placement. Bevel both edges of members to be anchored in concrete. Shims shall be cedar shingles or redwood wedges.
   3. Install permanent grounds of dressed, preservative treated, key- beveled lumber not less than 2.5-1.25 cm wide and of the thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

3.05 PLYWOOD SHEATHING, SUBFLOORING, AND UNDERLAYMENT

A. Comply with printed installation requirements of the Referenced Standards, unless otherwise indicated.

B. Plywood Underlayment: Unless shown on the Drawings, install underlayment just prior to installation of finish flooring. Stagger end joints between panels in relation to each other and stagger all joints in relation to substrate jointing. Allow 0.8 mm space between panel ends and edges for expansion. Fasten in accordance with the requirements. Prior to installation of finish flooring, patch damaged areas wider than 1.5 mm. Set nails 1.5 mm, but do not fill. Sand rough areas smooth and uneven joints flush.

3.06 PARTICLEBOARD UNDERLAYMENT

A. Install underlayment in accordance with the requirements of ES 1641.

3.07 WALL PLATES

A. Unless specified otherwise comply with ES 1653 for fixing wall plates.
   1. Use one piece of timber only for wall plate lengths of less than 3 m.
   2. When making up wall plate lengths of 3 m and over, use the least practicable number of separate pieces, with the shortest piece of sufficient length to support at least three joists or trusses.
   3. Join pieces with half lap running joints not less than 100 mm and twice nail.
   4. Fix wall plates in accordance with the requirements of ES 1653.

3.08 STRUCTURAL FLOORING

A. Unless otherwise indicated, fix structural flooring for joist/wall connections, joist to joist connections to form trimmers, joist to joist connections at right angles, floor bracing and strutting in accordance with the recommendations of ES 1653.

3.09 ROOF BRACING AND TRUSSED RAFTER

A. Fix roof bracing complying with the requirements of Section 061753 in this Specification.

3.10 TRUSSED RAFTERS

A. Construct and fix trussed rafters complying with the requirements of Section 061753 in this Specification.

3.11 STUD WALLING

B. Construct stud walling in accordance with the recommendations stated in ES 1653.

END OF SECTION

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SECTION 061753

WOOD TRUSSES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Rough Carpentry: Section 061000.

1.02 REFERENCES

A. EBSC EN 1995-1-1:2015: EBSC 5: Design of Timber Structures.

B. ES 1763: Timber Structures – Product Requirements for Prefabricated Trusses Using Punched Meta Plate Fasteners.

C. ES 1653: Workmanship on Building Sites. Code of Practice for Carpentry, Joinery and General Fixings.

D. ES 1950: Structural Use of Timber. Code of Practice for the Preservative Treatment of Structural Timber.

E. BS 5268-3: Structural Use of Timber – Part 3: Code of Practice for Trussed Rafter Roofs.

1.03 DESIGN REQUIREMENTS

A. Wood trusses shall be designed as per the requirements of EBSC EN 1995-1-1:2015.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Unless clearly specified otherwise in the Contract Drawings, shop drawings shall include truss framing plans, truss elevations, locations and details of connector plates, bearing and anchorage details, bracing and connection details, species and grades of timber, and connections required for the support of other Work.

B. Quality Control Submittals:
   1. Design Data:
      a. Connector plate evaluation information.
      b. Timber design values.
      c. Design calculations stamped and signed by a licensed Professional Engineer.

   2. Wood Treatment Certification: Submit "Certificate of Treatment" for timber used to fabricate trusses and bracing, stating that treatment complies with specified standards.

1.05 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that complies with quality-control procedures for manufacture of connector plates.
   1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
   2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that complies with quality-control procedures and that involves third-party inspection by an independent testing and inspecting agency.

C. Source Quality Control: Grade Marks: Each piece of timber shall be stamped with a grade mark and registered symbol of a grading agency certified by the recognized organization.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: The delivery, storage and handling of materials shall comply with the requirements of ES 1653, BS 5268-3 and the following.
   1. Protect trusses from moisture, warping, and distortion.
   2. Use methods of handling and storage which will maintain truss alignment and prevent loosening of joints.
   3. Store trusses off the ground on sufficient blocking to prevent damage.
   4. Protect trusses from moisture in a manner that allows adequate ventilation.
   5. Furnish components as needed to prevent damage while lifting and handling completed trusses.

PART 2 PRODUCTS

2.01 TIMBER

A. General: Timber generally shall be to EBSC EN 1995-1-1:2015 and to be of mature growth, properly seasoned and to nominal sizes indicated.
   1. The moisture content of the timber is to be maintained at no more than the requirements stated in ES 1653.

B. Post truss and rafter: Truss and rafter shall be fabricated from eucalyptus or other equivalent posts complying with the Referenced Standards.
   1. Members shall be spliced where necessary, securely nailed or bolted to each other and tied with mild steel bands at all splices and joints.
   2. Trusses and rafter shall be securely tied or bolted to the support as detailed or specified on drawings. Where no details are shown the bottom members shall be securely tied using 6 or 8mm diameter mild steel round bars embedded in concrete or masonry or welded to or tied around steel or timber supports.
   3. The member receiving purlins shall be uniform in elevation oil trusses and rafters along the length of the purlin. No truss or rafter member shall be notched to receive purlins. Notched member shall be removed and replaced unless approval is given to rectif^{y} by inserting wedges. Only sawn timber shall be used for wedging.

C. Sawn timber trusses and rafters: Trusses and rafters shall be fabricated from sawn timber complying with the requirements of the Referenced Standards.
   1. Truss members and rafters shall be overlapped or spliced at locations shown on drawings. Changes of locations of splices and overlaps require prior approval.
   2. Truss members shall be securely nailed, screwed or bolted together as detailed on drawings. The nails, bolts and screws to be used for the works shall comply with the requirements of applicable Standards.
   3. If additional ties to secure the members in position are shown on drawings or instructed such ties shall be made in steel bands. Wedges and seats shall be in sawn timber and provided as detailed on drawings or as instructed.
   4. The members receiving purlins shall be uniform in elevation on all trusses and rafters along the length of the purlin. No truss or rafter member shall be notched to receive purlins. Notched members shall be removed and replaced unless approval is given to rectify by inserting wedges.
   5. Trusses and rafters shall be securely tied or bolted to supports as detailed on drawings. Where no details are shown, the bottom members shall he tied to the support using 6 or 8mm diameter mild steel round bars embedded in concrete or masonry or welded to or tied around steel or timber posts.

2.02 FASTENERS

A. All nails and bolts used in trussed rafter roof construction, including those used with metal plate fasteners or plywood gussets, should either be inherently corrosion resistant or coated protectively by hot-dip galvanizing, sherardizing or any other suitable treatment against corrosion complying with applicable Referenced Standards.

2.02 FABRICATION

A. The fabrication of trussed rafter roofs shall comply with the requirements of BS 5268-3.
   1. The selection of timber and production of trussed rafters shall be performed by skilled staffs priory approved by the Engineers Representative.
   2. Provide suitable equipment for handling of materials and completed trussed rafters.
   3. Provide suitable equipment for the cutting of timber components capable of producing accurate and consistent angles and lengths.
      a. Cut members accurately to length and angle as indicated.

   4. Assemble trusses in accurate configuration and true alignment, with tight joints.

2.03 PRESERVATIVE TREATMENT

A. Treat timber where indicated and as specified. The preservative treatment for structural timber shall comply with the requirements of ES 1950.

B. Complete fabrication of items to be treated to the greatest extent possible prior to treatment. Where items must be cut after treatment, coat cut surfaces with two brush coat of the same chemical used for treatment or other solution recommended by ES 1950 Standards for the treatment.

C. Inspect timber after treating and drying. Discard warped or twisted items.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine surfaces to receive wood trusses and bracing for defects that will adversely affect the execution and quality of the Work. Do not proceed until unsatisfactory conditions are corrected.
   1. Verify that supports are ready to receive trusses.
   2. Verify that there is sufficient end bearing area.

3.02 ERECTION

A. General: The erection of trussed rafter roofs shall comply with the requirements of BS 5268-3.
   1. Do not cut, notch, or otherwise alter trusses without the prior approval of the Engineer's Representative.
   2. Set and secure trusses plumb and level in the designed locations.
      a. Tolerance: Comply with the requirements of applicable Referenced Standards.

   3. Provide temporary bracing and anchorage as required to maintain trusses in position and alignment until permanent bracing and anchorage is installed.
   4. Install permanent bracing and anchors prior to application of any loads.
   5. Shim trusses at interior load bearing walls if they do not meet. Lower interior walls and partitions if they are too high.

END OF SECTION

SECTION 062000

FINISH CARPENTRY

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Wood Doors: Section 081400.

B. Finish Hardware: Section 087100.

1.02 REFERENCES

A. EBSC EN 1995-1-1&2:2015: EBSC 5: Design of Timber Structures.

B. ES 1653: Workmanship on Building Sites. Code of Practice for Carpentry, Joinery and General Fixings.

C. ES 2084: Timber Structures – Structural Laminated Veneer Lumber – Requirements.

D. ES 1950: Structural Use of Timber. Code of Practice for the Preservative Treatment of Structural Timber.

E. ES 3277: Wood-Based Panels – Guidance on the Use of Load-Bearing Boards in Floors, Walls and Roofs.

F. ES 1669: Code of Practice for Flooring of Timber, Timber Products and Wood Based Panel Products.

G. ES 3735-51: Glue for Wood Working – Specification.

H. ES 1270: Specification for Nails: Steel Nails.

I. ES 3734-21: Wooden File Cabinets – Specification.

J. ES 3734-22: Office Wooden Shelving Rock with Glass – Specification.

K. ES 3734-41: Office Bookcase, Wood – Specification.

L. BS 6100-4-4: Glossary of Building and Civil Engineering Terms. Part 4. Forest Products: Section 4.4 Carpentry and Joinery.

M. BS 6446: Specification for Manufacture of Glued Structural Components of Timber and Wood Based Panels.

1.03 DEFINITIONS

A. Comply with the terms and definitions stated in Section 061000 in this specification including the following:

1. Newel: Post that supports the ends of one or more outside strings, handrails or winders.
2. String: Component that supports the ends of steps or landings.
3. Tenon: Projection at the end of one framed member, of lesser cross section than the member, intended to fit into a corresponding hole or slot in the other member to which it is thereby joined.
4. Molding: Profiled member or profile in section cut upon a member.
5. Blocking: Piece of timber fixed as a stiffener in angles, as in stairs, the heads of double hand sash windows, etc.

1.04 SUBMITTALS

A. product data:
   1. Submit product data for approval by the Engineer before fabrication of materials and components indicating the following:
      a. Proposed type of timber posts and laminated panel to be used.
      b. Proposed methods of impregnating timber & poses.
      c. Proposed place of fabrication of joinery.

B. Shop Drawings:
   1. Show fabrication details and connections to adjacent Work.

C. Samples:
   1. Samples of each type of work in its component material, fabricated, assembled fixed and finished form shall be produced as required for approval by the Engineer.

D. Quality Control Submittals:
   1. Dip Treatment Certificates: Certification by treating plant stating chemical solutions used, submersion period, and conformance with specified standards.
   2. Pressure Treatment Certificates: Certification by treating plant stating chemicals and process used, net amount of salts retained, and conformance with specified standards.

1.05 QUALITY ASSURANCE

A. All materials and work thereafter shall in all respects, comply with the approved samples.

B. Mill and producer's label:
   1. Each factory produced timber and panel item shall bear label indicating type, grade, mill, and grading agency on unfinished surface, or on end of material with finished surfaces.

C. Samples shall be maintained and kept in their original condition until permission to remove them is granted by the Engineer.

D. Pre-construction meeting:
   1. Meeting shall be conducted for consultation and exchange of information for laying flooring works at early date among parties concerned with the building operation, so that each may have full knowledge of the work and be able to cooperate in producing the conditions required by the others to ensure satisfactory completion.
   2. The exchange of information shall include but not limited to points stated in ES 1669 whichever are applicable.

1.06 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage and handling of materials shall comply with the requirements of ES 1653. For flooring materials comply with ES 1669.
   1. General:
      a. Keep the site clean and tidy in order that the checking, handling and storage of materials and components can be carried out speedily and effectively.
      b. Program deliveries in accordance with the contract program, to reduce site storage to a minimum.
      c. Prepare storage arrangements for each item in advance of delivery.
      d. Unload straight into the designed storage space.

   2. Delivery:
      a. Carry out detail checks on delivery in accordance with the criteria set out in ES 1653. In particular;
         1) Check quantities during unloading.
         2) Check for damage to manufactured components during unloading.
         3) Carry out moisture measurement on all manufactured joinery components as soon as possible after delivery. [The most convenient way to measure moisture content on site is by means of an electrical resistance moisture meter used in accordance with the manufacturer's direction].
            a) Check against the values of moisture content set out in ES 1653.

      b. Reject items which fail on any aspect of condition or specification.

   3. Handling:
      a. When handling, ensure that the items are not subject to stresses greater than those that they will sustain once installed. In particular:
         1) Support flat, planer items at all corners.
         2) Support linear items adequately along their length to avoid undue 'bow'.

   4. Storage:
      a. Provide storage in accordance with the criteria set out in ES 1653 to ensure that materials and components are maintained free from damage and are in conditions suitable for their specified moisture content.
         3) Store materials by complying with the minimum height (usually 15 cm) above ground surface.
         4) Stack materials and components in accordance with the methods stated in ES 1653, and provide air circulation between stacks.
         5) Protect against exposure to weather and contact with damp or wet surfaces.
         6) Cover stored materials and components with flexible or rigid sheets until ready for use for protection from moisture.
            a) Place and anchor cover in a manner that will provide good cross ventilation between the top of the items stored and the covering.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Maintain constant minimum temperature and maximum relative humidity as per the requirements of the referenced standards to receive the Work of this Section.

PART 2 PRODUCTS

2.01 MATERIALS

A. Timber:

1. General: Timber generally shall be to EBSC EN 1995-1-1&2:2015 and to be of mature growth, properly seasoned and to nominal sizes indicated. The actual sizes shall be within manufacturing tolerances allowed by the standard under which product is produced.
    a. All characteristics affecting the strength of the timber, i.e. arras, face, margin, splits, knots, edge knit, wane, defect ratio, slope of grain and the like shall comply with the requirements of the standards referred to above indicated.
    b. Timber ready for use shall be free from live borer, beetle, fungus or other insect attack. Timber for use or already used shall be removed and replaced if found defective and indication of their being attacked is evident or discovered.
    c. The moisture content of the timber is to be maintained at no more than the requirements stated in ES 1653.

2. Timber for joinery backing: Timber for the backing of joinery works like ceiling, soffits, cladding, doors, windows, built-in furniture shall comply with the requirements of applicable Referenced Standards.
    a. Timber shall be milled if required by the nature of the joinery works.
    b. Members shall be selected for uniformity of dimension and straightness.
    c. Members shall be, placed set at spacing shown on drawings and securely nailed or glued depending on the type of joinery.
    d. Timber in one length shall be used for joinery backing. Where the joinery work requires shop drawing, the method of jointing shall be approved prior to production. Where cross members are placed, such cross members shall be securely nailed or glued together to ensure that no displacement occurs while the joinery facing is placed on the timber backing.

3. Timber for flooring:
    a. Unless specified otherwise in the Contract Documents, the type of timber suitable for a particular use (e.g. flooring for pedestrians, gymnasium, industrial, decorative, chemical and acid resistance, etc.) shall be selected in accordance with the recommendations stated in ES 1669.

B. Fasteners:

1. Use fasteners of suitable length & appropriate type for the different fixing conditions complying with the requirements and as set out in applicable Referenced Standards.

C. Glue:

1. Comply with the requirements of ES 3735-51.

2.02 OFFICE BOOKCASE, WOOD

A. Comply with ES 3734-41.

2.03 CABINETS AND COUNTERTOPS

A. Comply with applicable Referenced Standards.

B. Cabinets:
   1. Wooden File Cabinets: Comply with ES 3734-21.
   2. Cabinet Hardware: As specified.

2.04 OFFICE WOODEN SHELVING ROCK WITH GLASS

A. Comply with ES 3734-22.

2.05 PRESERVATIVE TREATMENT

A. Treat timber where indicated and as specified. The preservative treatment for structural timber shall comply with the requirements of ES 1950.

B. Unless specified otherwise complete fabrication of items to be treated to the greatest extent possible prior to treatment. Where items must be cut after treatment, coat cut surfaces with two brush coat of the same chemical used for treatment or other solution recommended by ES 1950 for the treatment.

C. Inspect timber after treating and drying. Discard warped or twisted items.

2.06 FABRICATION

A. Comply with the requirements of BS 6446 for manufacturing glued structural components of timber and wood based panels.
   1. Color: As selected by the Engineer from the manufacturer's standard colors.

B. Machine and sand wood surfaces to comply with the requirements of applicable Referenced Standards.

C. Mill assemble items to largest sizes practicable, to minimize field cutting and jointing. Allow for cutting and fitting where necessary to fit at the Site.

2.07 FACTORY APPLIED PROTECTION

A. Protect glued laminated members before shipping by wrapping each member with factory applied, durable, water resistant, plastic coated paper covering, with water resistant seams.
   1. Bundle-wrap small members of uniform size, with protective slip sheets between members.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine substrate conditions and surfaces upon which finish Work is to be installed. Do not proceed with finish Work until unsatisfactory substrate conditions are corrected.

B. Do not install finish lumber or millwork in any room or space where wet process systems, such as concrete, masonry, or plaster work are not complete and dry.

3.02 PREPARATION

A. Preparation: Unless specified otherwise, comply with the requirements of ES 1653 for preparation and the following before erection and installation:
   1. Do not overload any part of the structure by stacking excessive quantities of materials or components.
   2. Place any materials and components that are stored on upper floors near to the walls on which the joists bear and distribute the materials to avoid point loads.
   3. Clean out all shavings, sawdust, offcuts and other rubbish from voids before these are close in, and as the work proceeds.
   4. Before fixing or building-in any components ensure that surfaces that will be hidden are primed or sealed as specified.
   5. Treat all surfaces of preservative treated timber exposed in cutting, with two brush applied flood coats of the appropriate preservative. Where primed timber is cut, prime the cut faces of the external joinery, working the priming coating well into the end grain of the timber.
   6. Ensure that the moisture contents of joinery timber sections and components, when built into the work, comply with the moisture content requirements stated in ES 1653.
   7. Before fiber building boards are fixed, adjust the moisture content in accordance with the requirements stated in ES 1653.
   8. Obtain instructions in the case of boards other than fiber boards.

3.03 INSTALLATION

A. Securely brace timber members or components temporarily during construction to hold them in position, to prevent displacement by wind or other forces and to prevent straining unfinished work.

B. Install Work of nominal sizes indicated or of units built-up to dimensions indicated, on spacing shown. Unless otherwise indicated, comply with the requirements of ES 1653. Construct required openings for installation of related work. Do not splice structural members between supports.

C. Install the Work plumb, level, and free of distortion. Shim where required, with concealed shims.

D. Cut wood items to fit unless specified to be shop-fabricated, or shop-cut to exact size. Scribe and cut for accurate fit where Work abuts other finish Work. Drill pilot holes at corners before making cutouts.

E. Distribute defects to the greatest appearance advantage possible.

F. Trim and Molding: Install in single, un-jointed lengths at openings and for runs less than the maximum timber length available. For long runs, use only 1 piece less than the maximum length available in any straight run. Stagger joints in adjacent members.

G. Install miscellaneous blocking and framing indicated and as required for attachment and support of facing materials, fixtures, specialty items, and trims.

H. Treated Wood: Apply two brush coats of treatment material to field cut surfaces where necessary.

I. Nailing: Anchor and nail members as indicated. If not indicated, comply with the requirements of ES 1653 for type of nails to be used, appropriate application and nail spacing.

J. Screwing and bolting: Comply with and follow the requirements of ES 1653.

K. Gluing: Follow the adhesive manufacturer's recommendations with respect to shelf life, mixing, environmental conditions for application and curing, moisture content of members and all other factors relevant to the proper use of adhesives.
   1. Ensure that the surface to be glued are freshly prepared, clean and free from dirt, dust, oil or other contamination likely to affect the performance of the adhesive, and that there is close contact of the surfaces over the area to be joined.
   2. Apply sufficient glue evenly over the surfaces to ensure that, after application of the bonding pressure, an unbroken glue line is obtained.

3.04 FIXING LOOSE JOINERY

A. Unless specified otherwise in the Contract Documents, the work of fixing for loose joinery shall comply with the requirements of ES 1653.
   1. Accuracy: Provide a true flat surface and when sheets and boards are fixed, the inaccuracies shall be within permitted deviations of the requirements of ES 1653.
      a. Make any adjustments to the supports to correct excessive inaccuracies.

   2. Timber board external cladding:
      a. Check that all fixtures and features around which the cladding is to be fixed have been installed.
      b. When boards are to lap, maintain the specified lap throughout.
      c. Use nails as specified, and where required to be stopped, punch them at least 2 mm below the surface.
      d. Make running joints in boards neatly and center over a support. Stagger running joints in adjoining rows of boards.
      e. Before fixing, ensure that the boards have been primed, sealed or given at least one coat stain in accordance with the site work instructions.
      f. Ensure that the cladding when fixed shows a true, even surface free from undulations and other defects.

3.05 FLOORING

A. Unless specified otherwise in the Contract Documents, the work of flooring of wood and wood products shall comply with the requirements of ES 1669.
   1. Ensure that the building is weather-tight and dry in the area where the flooring is to be laid.
   2. Board and strip:
      a. Spans for tongued and grooved softwood board should be not greater than the values given in ES 1669.
      b. Maximum spans for hardwood boards for sports halls, gymnasia, etc. should not exceed 300 mm.
      c. Processing to accurately finished size shall be completed before the flooring is delivered to the site.

d. Tongued and grooved strip flooring shall be secret nailed at each intersection with a joist or batten.
e. Tongued and grooved boards of 100 mm or less in width shall be secret nailed through the tongued edge at each intersection with a joist or batten.
f. Hardwood and softwood strip flooring and hardwood board flooring shall be sanded and finished with a seal. Subsequently, it shall be either wax polished or given an oil treatment.

3. Overlay and parquet:
   a. Parquet and overlay shall be supported on a base of concrete. When plywood is used as a base, it shall be of the factory sanded quality (at least good one side) and shall be laid with the face uppermost.
   b. Parquet panels shall be supplied square, framed and grooved around the edges to accommodate tongues.

3.06 FIXING MANUFACTURED JOINERY COMPONENTS

A. Unless specified otherwise in the Contract Documents, the work of fixing for manufactured joinery components shall comply with the requirements of ES 1653.
   1. Cupboard units:
      a. Before fixing, ensure that provision has been made for all services and, where necessary, that services are fixed in position.
      b. Fix cupboard units in position and ensure there is a neat fit to adjoining surfaces. Scribe edges or cover strips as necessary to achieve this.
      c. Ensure that wall units are securely and adequately fixed to the wall with screws that give at least 35 mm hold into the timber framing or bearers or into proprietary plugs in the masonry walls.

   2. Staircases:
      a. Where carriages and brackets are used, ensure that carriages bear fully and tightly at top and bottom and fix at both points. Check that brackets are tight against the underside of treads.
      b. Ensure that strings are accurately tenoned into newels and that newels stand straight and firm. Pin twice with hardwood dowels or steel pins.
      c. Where balusters are not housed into the string and handrail, butt tightly and twice screw.
      d. Fix wall handrails securely at a slope parallel with the wall string.
      e. Plug wall strings securely to walls at each alternative tread using the appropriate screws.
      f. On concrete floors, place a felt strip under the foot of the stair to prevent direct contact between the timber and the concrete.

3.07 CLEANING

A. Clean exposed surfaces of prefinished Work.

3.08 QUALITY CONTROL

A. All members of timber construction shall be correctly positioned as specified.

B. All fixings shall be provided as specified.

C. All nails, screws and bolts and packing shall be properly tightened.

D. All work shall be inspected whilst in progress and after completion.
   1. Flooring: Special attention shall be given to those possible defects stated in ES 1669 for each flooring work.

3.09 PROTECTION

A. Protect installed Work from damage by Work of other trades. Maintain temperature and humidity requirements during the construction period in interior installation areas.

END OF SECTION

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DIVISION 07 – THERMAL AND MOISTURE PROTECTION

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Ministry of Construction

SECTION 071000

DAMP-PROOFING AND WATERPROOFING

PART 1 GENERAL

1.01 REFERENCES

A. ES 1652: Workmanship on Building Sites. Code of Practice for Waterproofing.

B. ES 3145: Code of Practice for Design and Installation of Damp-Proof Courses in Masonry Construction.

C. ES 2478: Flexible Sheets for Waterproofing - Bitumen Sheets for Roof Waterproofing - Determination of Adhesion of Granules.

D. ES 2479: Flexible Sheets for Waterproofing - Bitumen, Plastic and Rubber Sheets for Roofing - Method of Artificial Ageing by Long Term Exposure to Elevated Temperature.

E. BS 743: Specification for Materials for Dump-Proof Course.

F. BS 6100:1.3.1: Glossary for Building and Civil Engineering Terms – Part 1. General and Miscellaneous – Section 1.3 Parts of Construction Works – Subsection 1.3.1 Walls and Cladding.

G. BS 6100:1.3.2: Glossary for Building and Civil Engineering Terms – Part 1. General and Miscellaneous – Section 1.3 Parts of Construction Works – Subsection 1.3.2 Roofs and Roofing.

1.02 DEFINITIONS

A. The terms under this Section shall comply with the definitions of BS 6100-1-3-1 and BS 6100-1-3-2 and the followings;
   1. Waterproofing includes the supply and application of waterproofing material to roofs and terraces of buildings.
   2. Damp proofing includes the supply and application of damp proofing material to vertical and horizontal surface of buildings.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications and installation instructions, for each material specified.

1.04 QUALITY ASSURANCE

A. The specifications, bill of quantities or schedules of waterproofing and damp-proofing indicate the proprietary item intended to establish the standard. The Contractor may submit other products meeting or exceeding the standards set by the proprietary item. Determination of the equivalence shall be the sole judgment of the person designated to give approvals and directions.

B. Manufacturer's specification and other data required to demonstrate compliance with the Standards and Specification shall be submitted for approval prior to placement of order.

C. Qualifications: Waterproofing and damp-proofing shall be executed by skilled workmen who are thoroughly experienced and familiar with the trade
   1. The waterproofing applicator must have been actively installing waterproofing and/or roofing systems for the past 5 years.
   2. The waterproofing applicator must have previously installed and completed a minimum of 5 waterproofing and/or roofing projects of comparable scope and complexity to the Work of this Section.
   3. The person supervising the Work of this Section and the workers applying the waterproofing materials shall have had at least 3 years of experience in the application of waterproofing and/or roofing materials.

D. Pre-waterproofing Conference: Before the waterproofing Work is scheduled to commence, a conference will be called by the Engineer's Representative at the site for the purpose of reviewing the Drawings and the Specifications and resolving all questions. The conference shall be attended by the Contractor, the authorized waterproofing applicator and the onsite field supervisor, and the waterproofing membrane manufacturer's or supplier's Company Field Advisor.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver all materials to the site in the manufacturer's labeled, unbroken containers. Membrane rolls must be packaged in rigid containers to prevent membrane distortion.

B. Storage:
   1. Do not double stack pallets of membrane.
   2. Store all materials on wooden platforms in a well-ventilated place.
   3. Store insulation and protection board flat.
   4. Cover all materials on top and sides with tarpaulins allowing for adequate ventilation. Keep materials dry at all times.
   5. Store all materials away from high heat, flames, and sparks.

C. Handling:
   1. Handle all materials in a manner to prevent damage. Mark and remove all damaged material from the site.
   2. Do not smoke or use open flames near primer, mastics, or liquid membrane.

1.06 PROJECT CONDITIONS

A. Do not execute the Work of this Section unless the Engineer's Representative is present.

B. Do not install the waterproofing membrane until the prepared concrete surface has been inspected by the membrane manufacturer's or supplier's Company Field Advisor.

C. Do not execute the Work of this Section unless the substrate is smooth, dry, and free of all dirt, dust and debris.

D. Apply damp-proofing in clear dry weather. Unless approved otherwise by the Engineer's Representative do not apply damp-proofing below 40 degrees F.

E. Limit the removal of existing waterproofing materials to areas that can be temporarily protected within the same day.

F. Maintain the building in a watertight condition at all time.

G. Do not apply the waterproofing system in areas where dust is being generated from adjacent work areas. If necessary erect temporary dust barrier or screens to keep the area being waterproofed clean and free of dust and dirt.

H. Membrane Protection: Cover all installed membrane with protection board immediately as the membrane is being installed. Do not install the protection board until the membrane has been inspected by the Engineer's Representative.
   1. No traffic will be allowed on the completed membrane until the protection board has been installed.

1.07 WARRANTY

A. Warranty Extension:
   1. The one year period required by the General Conditions of Contract is extended to 10 years for the Work of this Section.

PART 2 PRODUCTS

2.01 MATERIALS

A. In general, materials for waterproofing and damp -proofing shall comply with the requirements of the Referenced Standards including the followings;
   1. Materials shall be impervious to water, weather resistant and capable of withstanding without damage, minor structural movement.
   2. Waterproofing materials shall withstand without damage, limited traffic and light concentrated load associated with the installation and maintenance operation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete and masonry substrates are properly cured.

B. Verify that all fins and ridges have been removed and that all other surface defects have been corrected.

C. Verify that all openings around penetrations such as pipes, vents and structural members are sealed to prevent entry of waterproofing material.
   1. Testing existing drain system: Before commencing with the Work, water test all existing deck drains and conductor pipes. Submit a written report to the Engineer indicating which drains or conductors, if any, are not operating at full capacity.
      a. Repair of drains and conductors if not included in the Work, but may at the Procuring Entity's option be repaired by an Order on Contract.

D. Verify that drains are of the correct type and placed at the proper elevation to insure weepage at the membrane level.

E. Verify that the substrate is dry, free of dirt and debris and acceptable for application of the waterproofing. Do not commence installation until all unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. General: The preparation of substrate for waterproofing and dump-proofing shall comply with the requirements and recommendations of Referenced Standards.

B. Dump-proofing:
   1. Comply with manufacturer's printed recommendations for preparation of type of surface shown or indicated to receive damp-proofing.
   2. Thoroughly clean surfaces to be damp-proofed of soil, debris and all foreign matter. Allow cleaned surfaces to thoroughly dry.
   3. On porous surfaces, except new concrete masonry units, apply a uniform coating of asphalt primer.

C. Substrate to waterproofing:
   1. Allow fresh concrete, if any, to cure a minimum of 7 days before application of waterproofing membrane.
   2. Repair all concrete as required to provide a suitable surface for the waterproofing membrane. A clean, dry, smooth monolithic surface is required. A “broom” textured finish is not acceptable. The overall texture of the concrete shall closely resemble that of “steel trowelled” concrete.

3.03 APPLICATION OF DUMP-PROOF

A. General: Unless specified otherwise the application of dump-proof shall comply with the requirements of the Referenced Standards including the followings;
   1. Application shall be strictly in accordance with the manufacturer's instruction.
   2. Where waterproofing and damp-proofing is used as flushing, the flashing shall be executed concurrent with the installation of the water and damp proofing.

B. Provide continuous uniform damp-proofing coating, keeping the minimum dry thickness, on surfaces shown or scheduled to be damp-proofed. Apply damp-proofing by the appropriate or recommended material specified.

C. Unless specified on Contract Documents otherwise, damp-proof vertical wall surfaces to within 10 cm of finished grade at top of walls. At bottom of walls, extend damp-proofing across horizontal projection of footing and down face of footing approximately 5 cm.

3.04 INSTALLING WATERPROOFING MEMBRANE

A. General: Unless specified otherwise the installation of waterproofing membrane shall comply with the requirements of the Referenced Standards including the followings;
   1. The finished membrane shall be free of wrinkles, blisters, fish-mouths and any other defects which would impair the waterproofing qualities of the membrane. The membrane must be fully bonded to the substrate.

2. Immediately after installing each sheet of membrane or flashing, roll the entire surface to insure full contact with the substrate. Where a roller is not practical, use heavy hand pressure to firmly adhere the membrane.
3. Forming membrane at corners: At the intersection of inside and outside corners with horizontal surfaces, make a diagonal cut at the base of the cant to allow the membrane or flashing to conform to the contour of the corner and to eliminate wrinkles and bridging. Do not stretch the membrane.

3.05 FIELD QUALITY CONTROL

A. Inspection and repair:
1. Before the protection board is installed, inspect the membrane in the presence of the Engineer's Representative. Repair all defects which would impair the waterproofing qualities of the membrane. Defects requiring repairs include, but are not limited to, blisters, wrinkles, fish-mouths, cuts, punctures, bridging at corners, insufficient laps at edges and ends, and un-adhered membrane.
2. Cut out and patch all defects. Extend the patch a minimum of 6 inches beyond the defect in all directions. Apply a trowel coat of mastic around all edges of patch.

B. Thickness of Membrane:
1. During application, take frequent wet gage checks to assure sufficient coverage to obtain the specified dry film thickness.
2. When and where directed by the Engineer's Representative, make test cuts thru the cured membrane and measure the dry film thickness.

C. Flood testing: After completion and curing of the membrane, unless specified otherwise conduct a leakage test as follows:
1. Plug drains on horizontal surfaces.
2. Use sand bags or other approved means to restrict runoff.
3. Flood deck with water to a depth of two inches and allow to stand for 24 hours.
4. If leaks develop, make all necessary repairs and repeat test.

3.06 PROTECTION

A. General: Keep all unnecessary traffic off the completed membrane until protection board has been placed.

B. Cover all membrane surfaces with the specified protection board after flood testing, and before installing other Work.

END OF SECTION

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SECTION 076100

SHEET METAL ROOFING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Flashing and Trim: Section 076000.

B. Roof Specialties: Section 077100.

1.02 REFERENCES

A. ES 2882: Roofing Products from Metal Sheet – Specification for Self-Supporting Products of Steel, Aluminum or Stainless Steel Sheet – Part 3: Stainless Steel.

B. ES 1270: Specification for Nails – Part 1: Steel Nails.

C. ES 2868: Specification for Fixing Accessories for Building Purposes – Part 1: Fixings for Sheet, Roof and Wall Claddings.

D. BS 2465: Aluminum Fixing Accessories for Building Purposes.

E. CP 143: Code of Practice for Sheet Roof and Wall Coverings.

1.03 SUBMITTALS

A. Shop Drawings: Show manner of forming, jointing, and securing the Work.

B. Product Data:
   1. Manufacturer’s test certificate for metal sheet materials.
   2. Catalog sheets, specifications, and installation instructions for Sealant.

C. Samples:
   1. Sheet metal: 1, each type.
   2. Fasteners: 6, each type.
   3. Sealant: One cartridge.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Metal sheets shall be stored in a warm, dry & clean atmosphere to protect them from rust.

B. Metal sheets shall be stacked on off ground position and separated on ends using timber battens or similar materials approved by the Resident Engineer.

C. Metal sheets and fittings shall be kept clean of dirt and harmful chemicals.

D. Care should be taken that the sheets and fittings are not damaged during handling or transport.

E. All sheets and fittings including gutters and downpipes, fixing bolts and screws and any accessories required shall be on site or available before the Work is commenced.

PART 2 PRODUCTS

2.01 MATERIALS

A. Metal sheets: Aluminum, copper sheet, hot-dip metal coated steel sheet, metal plus organic coated steel sheet, stainless steel sheet or zinc sheet. Comply with CP 143 for the requirements of material & shape formation except for items specified under this Section.
   1. Comply with ES 2882 for stainless steel.
   2. Color: As selected by the Engineer from manufacturer's standard colors.

B. Fasteners:
   1. Steel nails: Shall comply with ES 1270.
   2. Screws, bolts, nuts, washers and other fastening accessories:
      a. Shall comply with ES 2868 in general.
      b. Shall comply with BS 2465 for aluminum sheets.

C. Sealant: Appropriate type of sealant approved by the Engineer.
   1. When flexible seals are required, bituminous mastic or other material of similar characteristics is recommended.

2.02 FABRICATION

A. Unless otherwise shown on the Drawings or specified, fabricate the required sheet metal roofing components from the appropriate materials and gages complying with the requirements of the Referenced Standards.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean and dry all substrates before installing the Work of this Section.

B. Secure loose or warped wood boards with nails. Set all protruding nails so that heads finish flush with the wood surface, or slightly below.

C. The holes of the fixing bolts should be made through the crown of the corrugation and should be either punched or drilled. Holes shall be 1.5mm larger in diameter than the diameter of bolts fixing screws used.

D. Holes for fixing the sheets should be in exact positions to suit the purlins. No holes for fixing bolt should be nearer than 38 mm to the ends of a sheet.

3.02 INSTALLATION

A. General:
   1. Unless specified in the Contract Documents otherwise the installation of sheet metal roofing shall comply with the requirements of CP 143.

2. Sufficient overhang shall be provided as weather protection for walls susceptible to dampness penetration.
3. Gutters and down pipes shall have a minimum overlap of 150mm at joints. Joints shall be welded/ soldered.
4. The area around joints and returns of gutters shall be treated with coating as gutters.
5. Apply appropriate sealing materials to locations indicated on the Drawings as per the manufacturer's installation instruction.

B. Layout of the sheeting: Unless specified on the Drawings otherwise comply with the following requirements:
   1. Galvanized corrugated steel:
      a. The purlin spacing and the length of the sheets shall first be checked to see that the arrangement will provide the specified overhang at the eaves and the laps.
      b. The eave course shall be laid first and work should start at the leeward end of the building, so that side laps will have the better protection from rain driven by the prevailing wind.
      c. The top edges or eaves sheets shall extend at least 38 mm beyond the back of the steel angle purlins or 75 mm beyond the center line of timber purlins.
      d. Roofing sheet shall be laid in accordance with the requirements of the Referenced Standards or manufacturer's instruction with end laps not less than 150mm and ride laps not less than one and half corrugation.

   2. Aluminum sheets:
      a. The techniques and sequence of laying aluminum fully supported roof shall comply with the recommendations stated in CP 143-15.
      b. The laying of aluminum corrugated and troughed sheet shall comply with the requirements of CP 143-1.

   3. Copper sheet:
      a. The methods, techniques and sequence laying of copper sheet shall comply with the requirements of CP 143-12.

C. Fixing the sheets:
   1. The sheets shall be fixed in accordance with the requirements of the referenced standards and the followings:
      a. The appropriate fixing materials shall be selected for specific sheet type of roofing materials.

D. Eaves and verges:
   1. The ends of all sheets should be supported, and the support should be placed as near to the margin of the sheet as practicable.

E. Ridge cap:
   1. The ridge cap shall be secured to the rig purlins by the same fastening material that secure the sheeting.
   2. The lap of the cap along the ridge shall be not less than 150 mm and so arranged to protect the joint from the prevailing wind.

3.03 FIELD QUALITY CONTROL

A. Workmanship:
   1. Tinning and Soldering:

a. Tin all surfaces of uncoated metal in contact with solder.
b. Wire brush all surfaces of coated metals in contact with solder. Produce a clean and bright surface.
c. Apply flux as required.
d. Sweat solder thoroughly into seams, completely filling the full width of the seam.
e. Upon completion of soldering, remove all traces of flux residue. If required, apply a neutralizing wash followed by a clean water wash.

2. Cross Folded Seams: Where sheet metal is cross folded at a right angle to the first fold, slit the folded portion of the metal at the cross fold and solder a metal patch over the slit to avoid binding.
3. Matching Existing Work: Tie the items of Work in with the existing Work to obtain watertight installation. Match the existing installation as much as practicable, unless otherwise specified. Repair and dress adjacent existing components as required to make secure and neat connections with new items.

END OF SECTION

Ministry of Construction

SECTION 076200

FLASHING AND TRIM

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Sheet Metal Roofing: Section 076100.

B. Roof Specialties: Section 077100.

1.02 REFERENCES

A. ES 2882: Roofing Products from Metal Sheet – Specification for Self-Supporting Products of Steel, Aluminum or Stainless Steel Sheet – Part 3: Stainless Steel.

B. ES 1270: Specification for Nails – Part 1: Steel Nails.

C. ES 2868: Specification for Fixing Accessories for Building Purposes – Part 1: Fixings for Sheet, Roof and Wall Claddings.

D. ES 3088: Code of Practice for Use of Masonry - Part 3: Materials and Components, Design and Workmanship.

E. CP 143: Code of Practice for Sheet Roof and Wall Coverings.

F. BS 6100:1.3.2: Glossary for Building and Civil Engineering Terms – Part 1. General and Miscellaneous – Section 1.3 Parts of Construction Works – Subsection 1.3.2 Roofs and Roofing.

1.03 DEFINITIONS

A. The terms in this Section shall comply with the terms and definitions stated in BS 6100:1.3.2.
   1. Flashing: Strip of impervious sheet material that protects a joint, usually from entry of rainwater.
   2. Cap sheet: Top layer in a number of layers of roofing sheet.
   3. Wedge: Folded piece of metal sheet, used in a masonry chase to secure a flashing.

1.04 SYSTEM DESCRIPTION

A. Metal flashings, trim, and related accessories that form terminations and waterproof connections.

1.05 SUBMITTALS

A. Shop Drawings: Provide shop drawings as per the details of the Contract Drawings. If the details are not covered in the Drawings, the shop drawing shall show the manner of forming, jointing, and securing the metal flashings and trim. Include expansion joint

connections, and the method of forming waterproof connections to adjoining construction.

B. Product Data: Submit the following as required:
   1. Catalog sheets, specifications, installation instructions for each item specified except for shop or job formed items, solder, flux, and bituminous paint.

C. Samples: Submit samples of quantities and size for each flushing materials and accessories as required by the Engineer's Representative and/or as per the following requirements.
   1. Materials for flashings: One 20 cm sq. piece, for each type material specified.
   2. Anchors: Six, each type required.
   3. Flashings: Full section, 15 cm long.

1.06 QUALITY ASSURANCE

A. Except as otherwise shown or specified, comply with applicable recommendations, details, and Referenced Standards.

B. Manufacturer's Recommendations:
   1. For factory fabricated items, follow the manufacturer's recommendations and installation instructions unless specifically shown or specified otherwise.

1.07 PROJECT CONDITIONS

A. Do not execute the Work of this Section unless the Engineer's Representative is present, or unless he directs that the Work be performed during his absence.

B. Make the roof and all uncompleted flashings watertight at the end of each work day.

PART 2 PRODUCTS

2.01 MATERIALS FOR FLASHING FABRICATION

A. Metal sheets: The material for flushing can be aluminum, copper sheet, hot-dip metal coated steel sheet, metal plus organic coated steel sheet, stainless steel sheet or zinc sheet. Use materials as indicated in the Contract Documents by complying the following requirements:
   1. Comply with CP 143 for the requirements of materials and shape formation except for those items specified under this Section.
      a. Comply with ES 2882 for stainless steel.
      b. Comply with ES 3088 for the materials to be used for masonry works.

   2. Color: As selected by the Engineer's Representative from manufacturer's standard colors.

2.02 FASTENERS

A. Unless specified otherwise comply with the requirements of ES 2868.
   1. Comply with ES 1270 as an alternative for steel nails.

2.03 MISCELLANEOUS MATERIALS

A. Sealant: Unless specified in the Contract Documents, use appropriate sealant material in accordance with applicable Referenced Standards.

2.04 FABRICATION

A. Where practicable, form and fabricate sheet metal Work in the factory or shop. Produce bends and profiles accurately to the indicated shapes. Where not indicated or specified, follow the applicable requirements of the Reference Standards.

PART 3 EXECUTION

3.01 EXAMINATION

A. Coordinate the Work of this Section with other Work for the correct sequencing of items that make up the entire system of weatherproofing or waterproofing.

3.02 PREPARATION

A. Do not install the Work of this Section unless all necessary nailers, blocking and other supporting components have been provided.

B. Do not install the Work of this Section unless all substrates are clean and dry.

3.03 INSTALLATION

A. General: The installation of flashing shall be performed in accordance with the requirements of applicable Referenced Standards.
   1. Follow the procedures as per the requirements of ES 3088 for the installing flashings on masonry works.

B. Isolation: Separate dissimilar metals from each other with bituminous paint.

C. Tinning and Soldering:
   1. Remove all factories applied finishes to bare metal at all areas to be soldered.
   2. Clean, flux and tin all surfaces to be soldered.
   3. Sweat solder thoroughly into seams, completely filling the seam for the full width.
   4. Upon completion of soldering, remove all traces of flux residue, and if required, apply a neutralizing wash followed by a clean water wash.

D. Touch-up painting: After all prefinished galvanized steel flashings have been installed, apply the metal coating manufacturer’s touch-up paint to all soldered areas and all other areas where the finish has been damaged.

E. Installing cap flashing: Unless indicated on Drawings, comply the following:
   1. Form and install the cap to provide a spring tight fit against the base flashing. Lap all end joints and base flashing a minimum of 10 cm. Extend the cap continuously around corners or provide lock seams.
   2. Cap flashing for installation in reglets:

a. Extend the built in portion of the cap a min of 2 cm into the reglet. Form the edge of the built in portion with a 0.65 cm hook dam.
b. Secure the cap with lead wedges 20 cm on centers. Fill joint completely with appropriate type of sealant and tool to a slightly concave surface.

3. Surface mounted cap flashing:
   a. Form the top portion of the cap flashing which comes in contact with the wall surface with a 2.5 cm wide bearing surface. Form a 45 degree x 0.65 cm wide stiffener and caulking flange along the top edge.
   b. Apply appropriate type of sealant on the back side of the bearing surface.
   c. Secure the cap flashing to the wall with fasteners spaced 30 cm on centers thru the bearing surface.
   d. Apply appropriate type of sealant along the caulking flange.

4. In-wall cap flashing:
   a. Extend the built-in portion of the cap a minimum of 10 cm into the wall. Form the edge of the built in portion with a 0.65 cm hook dam.
   b. Set the cap so there is mortar above and below the built-in portion.

F. Door and window flashing:
   1. Install the flashing in one continuous length from side to side.

END OF SECTION

SECTION 077100

ROOF SPECIALTIES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Sheet Metal Roofing: Section 076100.

B. Flashing and Trim: Section 076200.

1.02 REFERENCES

A. ES 3088: Code of Practice for Use of Masonry - Part 3: Materials and Components, Design and Workmanship.

B. EN 612: Eaves Gutters and Rain-water Downpipes of Metal Sheet – Definitions, Classifications and Requirements.

C. EN 607: Eaves Gutters and Fittings Made of PVC-U – Definitions, Requirements and Testing.

D. CP 143: Code of Practice for Sheet Roof and Wall Coverings.

E. BS 1091: Specification for Pressed Steel Gutters, Rainwater Pipes, Fittings and Accessories.

F. BS 1494: Specification for Fixing Accessories for Building Purposes.

G. BS 2465: Aluminum Fixing Accessories for Building Purposes.

H. BS 5642: Part 2: Specifications for Copings of Precast Concrete, Cast Stone, Clayware, Slate and Natural Stone.

1.03 DEFINITIONS

A. The terms in this Section shall comply with the definition stated in the Referenced Standards including the following:
   1. Eaves gutter: A gutter situated outside the building and supported by brackets.
   2. Downpipe: A pipe fitted to a gutter to lead rainwater from the gutter to the drainage system or sewer.
   3. Accessories: All parts besides the gutter and downpipe which are necessary for the construction of rainwater drainage. Or all parts besides the coping necessary for its construction.
   4. Bead: A profile of partly circular or rectangular shape at the top of the front of a gutter.

1.04 SYSTEM DESCRIPTION

A. Copings, gutters, downpipes and related accessories.

1.05 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each material specified.

B. Samples:
   1. Gutter: 30 cm long, full section.
   2. Downpipe: 30 cm long, full section.
   3. Coping: 39 cm long, full section.
   4. Hanger Brackets, Braces, and Stiffeners: One, each type.
   5. Fasteners: Six, each type.
   6. Sealant: One pint or standard tube.
   7. Color Samples: Coil stock manufacturer’s standard range of colors for finish specified.

C. Shop Drawings: Show method of forming, jointing, and securing the copings, gutters and downpipes. Include attachment to adjoining construction.

1.06 DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store materials in a dry, protected, well-vented area.

C. Remove protective plastic surface film immediately before installation.

PART 2 PRODUCTS

2.01 GUTTER AND DOWNPIPE

A. Metal sheets: Aluminum, copper sheet, hot-dip metal coated steel sheet, metal plus organic coated steel sheet, stainless steel sheet or zinc sheet. Comply with CP 143 for the requirements of materials and shape formation except for those items specified under this Section.
   1. Eaves gutter and downpipe: Unless specified in the Contract Documents, the materials shall comply with the requirements of EN 612.
      a. Components: Eaves gutter formed from one piece of metal sheet, shall consist of the following four main parts:
         1) The bead.
         2) The front.
         3) The bottom, and
         4) The back.

      b. Thickness: The nominal material thickness for eaves gutter and downpipe shall be greater than the minimum requirements of EN 612.
      c. Tolerance: The dimensions of the shapes shall be within the tolerance limits of EN 612.

   2. Pressed steel gutters and downpipes: Comply with BS 1091.
   3. Fixing accessories and fittings:

a. Unless specified otherwise comply with the requirements of BS 1494, BS 2465, CP 143, BS 1091 or other applicable Referenced Standards as appropriate.

4. Color: As selected by the Engineer's Representative from manufacturer's standard colors.

B. PVC-U: The material for eaves gutter shall comply with the requirements of EN 607.
1. Fittings: The fittings (union clip, joint bracket, gutter adapter, angle, stop, etc.) shall conform the requirements of EN 607 for:
a. Appearance.
b. Shape and dimensions.
c. Physical properties

2.02 COPING

A. Comply with BS 5642 for precast concrete, cast stone, clayware, slate and natural stone.

B. Comply with ES 3088 for the materials to be used for masonry works.

2.03 FABRICATION

A. Fabricate copings, gutters, downpipes, and fittings to the shape and profile indicated on the Drawings. When fabrication details are not indicated follow the applicable requirements of the Referenced Standards.
1. Form eaves gutter in accordance with the shape requirements of EN 612.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not install the Work of this Section unless all necessary nailers, blocking and other supporting components have been provided.
1. Coordinate installation of roof perimeter flashing with installation of gutter system.

3.02 JOINING

A. Solder all metallic connections with appropriate lap width, riveted, and soldered seams complying with applicable Referenced Standards. Use appropriate size of diameter rivets spaced as indicated.

B. Tinning and Soldering:
1. Use appropriate type of soldering complying with applicable Referenced Standards.
2. Tin Surfaces of uncoated metal in contact with solder.
3. Wire brush surfaces of coated metals in contact with solder. Produce a clean and bright surface.
4. Apply flux as required.
5. Sweat solder thoroughly into seams, completely filling the full width of the seam.
6. Upon completion of soldering, remove traces of flux residue. If required, apply a neutralizing wash followed by a clean water wash.

C. Join steel sections with required lap width, riveted, and sealed seams. Seal seams with appropriate type of sealant within the lap and polyester cloth embedded in sealant over the entire joint. Use appropriate size of diameter rivets spaced as indicated.

3.03 INSTALLATION

A. Connection to Existing Construction: Tie the items of Work in with the existing work to obtain watertight installation. Match the existing installation as much as practicable, unless otherwise specified. Repair and dress adjacent existing components as required to make secure and neat connections with new items.

B. Installation of Gutters: Install gutters in accordance with the requirements of applicable Referenced Standards
   1. Install gutter hanger brackets as indicated. Install the brackets so there will be a slight pitch in the gutter towards the downpipes.
   2. Join and seal the gutter sections, end pieces, mitered corners, and outlet tubes.
   3. Install expansion joints where indicated on the drawings. If not indicated, place the expansion joints at mid points between the downpipes at maximum intervals of 1.2 m.
      a. Form the expansion joints with end baffles conforming to the shape of the gutter. Join the baffles to the gutter section.
      b. Install a cover plate over the baffle.

   4. Install a continuous stiffener bar along the top front edge of the gutter. Fold the gutter around the stiffener bar so it is securely locked in place.
   5. Install gutter braces as indicated, staggered from the gutter hanger brackets. Secure the braces to the stiffener bar and to the back vertical portion of the gutter with brass or copper bolts.
   6. Secure the top back edge of the gutter to the gravel stop, eave flashing, or continuous cleat as indicated on the drawings.

C. Installation of Downpipes: Install downpipes in accordance with the requirements of applicable Referenced Standards.
   1. Join the downpipe sections with end joints that telescope as indicated.
   2. Install necessary offsets and elbows.
   3. Fasten downspouts to hangers with sheet metal screws.
   4. Secure hangers to masonry and concrete walls with appropriate fixing accessories and to wood walls with screws.
   5. Discharge Elbows: Fasten leader shoes to downspouts with a minimum of 3 sheet metal screws.
   6. Connection to Underground Drains: Fit the downpipe neatly into the drain pipe or boot. Caulk the joint with appropriate material and seal with sealant.

D. Installation of copings: Install copings in accordance with the requirements of applicable Referenced Standards.
   1. Comply with the requirements of ES 3088 for the installation of copings for masonry works.

END OF SECTION

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SECTION 079200

JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section covers all sealant and caulking materials and their application, wherever required for complete installation of building materials or systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Glazed Aluminum Curtain Walls: Section 084413.

B. Glass and Glazing: Section 088100.

1.03 REFERENCES

A. ES 1665: Workmanship on Building Sites. Code of Practice for Sealing Joints in Buildings Using Sealants.

B. ES 2471: Building Construction – Jointing Product – Sealants – Vocabulary.

C. ES 2493: Specification for Two-Part Polysulphide-Based Sealants.

D. ES 2494: Specification for One-Part Gun Grade Polysulphide-Based Sealants.

E. ES 1389: Hot-Applied Joint Sealant Systems for Concrete Pavements. Specification for Joint Sealants.

F. ES 1390: Hot-Applied Joint Sealant Systems for Concrete Pavements. Code of Practice for the Application and Use of Joint Sealants.

G. BS 6213: Guide to Selection of Constructional Sealants.

1.04 DEFINITIONS

A. The terms in this Section shall comply with the terms and definitions stated in ES 2471.

1.05 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each product specified.

B. Samples:
   1. Sealants: One pint or standard tube.
   2. Joint Fillers: 30 cm long full section.
   3. Gaskets: 30 cm long full section.
   4. Joint Primer/Sealer/Conditioners: One pint.
   5. Backer Rods: 30 cm long full section.

6. Bond Breaker Tape: 30 cm long full section.

C. Quality Control Submittals:
   1. Installer's Qualifications Data: Affidavit required under Quality Assurance Article.
   2. Company Field Advisor Data: Name, business address, and telephone number of Company Field Advisor.

1.06 QUALITY ASSURANCE

A. Installer's Qualifications: The persons installing the sealants and their supervisor shall be personally experienced in the installation of sealants & shall have been regularly employed by a company engaged in the installation of sealants for a minimum of 2 years.
   1. Furnish to the Engineer the names and addresses of five similar projects which the foregoing people have worked on during the past two years.
   2. Furnish a letter from the sealant manufacturer, stating that the foregoing people are authorized to install the manufacturer's sealant materials and that the manufacturer's specifications are applicable to the requirements of this Project.

B. Source Limitations: Unless indicated in the Contract Documents, obtain each type of joint sealant through one source from a single manufacturer.

C. Pre-Work Conference: Prior to starting the Work and before materials are ordered, a conference will be held at the Site to discuss the specifications, details, and application requirements. The meeting shall be attended by the Contractor, the sealant applicator and the sealant manufacturer's Company Field Advisor.

D. Container Labels: Include manufacturer's name, trade name of product, kind of material, specification number (if applicable), expiration date (if applicable), and packaging date or batch number.

E. Test and validate sealants used for exterior weather-sealing as per the requirements of applicable Referenced Standards.

F. Warranties:
   1. Warranty exterior sealing against leaks, adhesion, and cohesive failure in addition to warranties made by Contractor under requirements of Contract Documents for the period as required by the Engineer.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Temperature: Unless otherwise approved or recommended in writing by the sealant manufacturer, install sealants within permissible temperatures in accordance with the requirements of applicable Referenced Standards.
   2. Humidity and Moisture: Do not install the Work of this section under conditions that are detrimental to the application, curing, and performance of the materials.
   3. Ventilation: Provide sufficient ventilation wherever sealants, primers, and other similar materials are installed in enclosed spaces. Follow manufacturer's recommendations.

B. Joint-Width Conditions:

1. Do not proceed with installation of joint sealants where joint widths are less than indicated or those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions:
1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

D. Protection:
1. Protect all surfaces adjacent to sealants with non-staining removable tape or other approved covering to prevent soiling or staining.
2. Protect all other surfaces in the Work area with tarps, plastic sheets, or other approved coverings to prevent defacement from droppings.

1.08 DELIVERY, HANDLING, AND STORAGE

A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.

B. Carefully handle and store to prevent inclusion of foreign materials.

PART 2 PRODUCTS

2.01 SEALANTS

A. Material:
1. Unless indicated in Contract Documents, the type of sealant material & caulking compound for specific purpose shall meet the requirements of applicable Referenced Standards.

B. Sealant Colors: For exposed materials provide color as indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors. For concealed materials, provide the natural color which has the best overall performance characteristics.

2.02 JOINT FILLERS

A. As indicated, if not comply with the requirements of applicable Referenced Standards.
1. Thickness same as joint width.
2. Depth to fill void completely behind back-up rod.

2.03 GASKETS

A. As indicated, if not comply with the requirements of applicable Referenced Standards.

2.04 MISCELLANEOUS MATERIALS

A. Joint Primer/Sealer/Conditioner: As recommended by the sealant manufacturer for the particular joint surface materials and conditions.

B. Backer Rod: Compressible rod stock of expanded, extruded polyethylene.

C. Bond Breaker Tape: Polyethylene or other plastic tape as recommended by the sealant manufacturer; non-bonding to sealant; self adhesive where applicable.

D. Cleaning Solvents: Oil free solvents as recommended by the sealant manufacturer. Do not use re-claimed solvents.

E. Masking Tape: Removable paper or fiber tape, self-adhesive, non-staining.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine all joint surfaces for conditions that may be detrimental to the performance of the completed Work. Do not proceed until satisfactory corrections have been made.

3.02 PREPARATION

A. Clean joint surfaces immediately before installation of sealant and other materials specified in this Section.
   1. Remove all loose materials, dirt, dust, rust, oils and other foreign matter that will impair the performance of materials installed under this Section.
   2. Remove lacquers, protective coatings and similar materials from joint faces with manufacturer's recommended solvents.
   3. Do not limit cleaning of joint surfaces to solvent wiping. Use methods such as grinding, acid etching or other approved and manufacturer's recommended means, if required, to clean the joint surfaces, assuring that the sealant materials will obtain positive and permanent adhesion.

B. Set joint fillers at proper depth and position as required for installation of bond breakers, backer rods, and sealants. Do not leave voids or gaps between the ends of joint filler units.
   1. Smooth Edged Joints: For joints between two concrete slabs or where new concrete abuts smooth edged materials use either cork joint filler or closed cell polyurethane joint filler.
   2. Irregular Edged Joints: For joints where new concrete abuts granite curbs or other irregular edges use closed cell polyurethane joint filler.

C. Priming Joint Surfaces:
   1. Prime joints which are to receive sealants as indicated or recommended by the manufacturer's printed instructions.
   2. Do not allow the primer/sealer to spill or migrate onto adjoining surfaces.

3.03 JOINT BACKING INSTALLATION

A. Install back-up material, to form joints enclosed on three sides as required for specified depth of sealant.

B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.

C. Install bond breaker tape in relaxed condition as it comes off the roll. Do not stretch the tape. Lap individual lengths.

D. Install backer rod of sufficient size to fill the joint width at all points in a compressed state. Compress backer rod at the widest part of the joint as per the requirements. Do not cut or puncture the surface skin of the rod.

E. Take all necessary steps to prevent three sided adhesion of sealants.

3.04 SEALANT INSTALLATION

A. Except as shown or specified otherwise, install sealants in accordance with the requirements of applicable Referenced Standards and/or the manufacturer's printed instructions.

B. Finishing: Tool all vertical, non-sag sealants so as to compress the sealant, eliminating all air voids and providing a neat smoothly finished joint. Provide slightly concave joint surface, unless otherwise indicated or recommended by the manufacturer.
   1. Use tool wetting agents as recommended by the sealant manufacturer.

3.05 FIELD QUALITY CONTROL

A. Test Samples:
   1. Where directed, for each 400 linear meter of joint installed, cut out and carefully remove a 15 cm long sample of the undisturbed sealant and joint backer material from the newly installed Work. Remove the samples in the presence of the Engineer's Representative who will retain them for evaluating and testing.
   2. Reseal cut out areas with the same materials.

3.06 CLEANING

A. Immediately remove misapplied sealant and droppings from metal surfaces with solvents and wiping cloths. On other materials, remove misapplied sealant and droppings by methods and materials recommended in writing by the manufacturer of the sealant material.

B. After sealants are applied and before skin begins to form on sealant, remove all masking and other protection and clean up remaining defacement caused by the Work.

END OF SECTION

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DIVISION 08 – OPENINGS

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Ministry of Construction

SECTION 081100

METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Finish Hardware: Section 087100.

B. Glass and Glazing: Section 088100.

1.02 REFERENCES

A. EBSC EN 1993:2015: Design of Steel Structures.

B. ES 913: Metal Sheet – Hot Rolled Steel Flat Products.

C. ES 1344: Specification for Metal Door Frames (Steel).

D. ES 1595: Specification for Steel Windows, Sills, Window Boards and Doors.

E. ES ISO 630-1: Structural Steels – Plates, Wide Flats, Bars, Sections and Profiles.

F. ES ISO 630-2: Structural Steels – Part 2: Technical Delivery Requirements for Hot-Finished Hollow Sections.

G. ES ISO 6929: Steel Products – Definitions and Classification.

H. ES ISO 4995: Hot-Rolled Steel Sheet of Structural Quality.

I. ES ISO 4997: Cold-Reduced Steel Sheet of Structural Quality.

J. ES ISO 6316: Hot-Rolled Steel Strip of Structural Quality.

K. ES ISO 4998: Continuous Dip Zinc Coated Carbon Steel Sheet of Structural Quality.

L. ES ISO 657: Hot-Rolled Steel Sections.

M. ES ISO 9328: Steel Flat Products for Pressure Purposes – Technical Delivery Conditions.

N. ES 1998: Internal and External Wood Door Sets, Door Leaves and Frames – Part 1: Specification for Dimensional Requirements.

O. ES 3139: Structural Use of Aluminum – Part 1: Code of Practice for Design.

P. ES ISO 209: Wrought Aluminum and Aluminum Alloys – Chemical Composition and Forms of Products.

Q. ES ISO 6361: Wrought Aluminum and Aluminum Alloy Sheets, Strips and Plates.

R. ES ISO 6362: Wrought Aluminum and Aluminum Alloy Extruded Rods/ Bars, Tubes and Profiles.

S. ES 2947: Building Hardware Cylinder for Locks – Requirements and Test Methods.

T. ES 2954: Building Hardware – Hardware for Sliding Doors and Folding Doors – Requirements and Test Methods.

U. ES 2966: Building Hardware – Door and Window Bolts – Requirements and Test Methods.

V. ES 2969: Building Hardware – Single Axis Hinges – Requirements and Test Methods.

W. ES 1524: Specification for Locks and Latches for Doors in Buildings.

X. ES 2983: Building Hardware – Locks and latches – Mechanically Operated Locks, Latches, and Locking Plates – Requirements and Test Methods.

Y. ES 1997-1: Glossary of Building and Civil Engineering Terms – General and Miscellaneous – Section 1.3: Parts of Construction Works – Subsections 1.3.5: Doors, Windows and Openings.

1.03 DEFINITIONS

A. The terms in this section shall comply with the terms and definitions of ES 1997-1 and the followings.
1. Opening: Void in a building element.
2. Jamb (1): Vertical part of a wall at an opening.
3. Jamb (2): Vertical side member of a frame of opening lining.
4. Lining: Dry covering to any internal building surface.
5. Frame: Surround to a door leaf, window, etc., that enables it to be fixed in position.
6. Door: Construction for closing an opening, intended primarily for access.
7. Door frame: Frame in which a door leaf moves.
8. Door jamb: Vertical side member of a door frame or door lining.
9. Door leaf: Movable part to close a door opening.
10. Door set: Complete unit supplied from a single source consisting of a door frame, door leaf or leaves, essential building hardware and weather strip.
11. Sill: Construction providing a seating for a frame or the lower member of a frame.
12. Transom: Horizontal member dividing an opening or frame of a window or door.
13. Threshold (1): Horizontal member located at the foot of a door frame.
14. Threshold (2): Horizontal part of a wall or floor at the boot of an opening.
15. Mullion: Intermediate vertical member in an opening or frame.

1.04 SUBMITTALS

A. Submittals Packages
1. Door and Frame Schedule and Shop Drawings Package: Submit as a complete package. Incomplete packages will be returned un-reviewed.
a. Quality Assurance Submittal:
1) Certification of Compliance as described in the Quality Assurance Article.
2) Company Field Advisor's Qualification Data (if required by the Engineer)
a) Name of Company Field Advisor and Employer's name, business address and telephone number and e-mail address.
b) Names and addresses of 3 similar projects Company Field Advisor has worked on during the past three years.
c) Written certification on metal door and frame manufacturer's letterhead that Company Field advisor is technically qualified in design, installation, and servicing of the products furnished for this Project.

3) Certified Supervisor's and Installer's Qualification Data

a) Name of Supervisor and each Installer performing Work, and Employer's name, business address and telephone number.
b) Names and addresses of 3 similar projects Supervisor and each Installer has worked on during the past three years.
c) Written certification on steel door and frame manufacturer's letterhead that Supervisor/Installer is technically qualified to ensure approved steel frames and doors are installed, adjusted, and operate properly.

b. Door and Frame Schedule:
1) Include a Cover Sheet that lists:
a) Project name, project number, and project address.
b) Manufacturer's name, address, and telephone number.
c) Distributor's name, address, and telephone number.
d) Shop drawing preparer's name, and telephone number and e-mail address.
e) Submission date.

2) List by opening
a) Door and Frame number and location by building and room name. Use same reference numbers for openings and as those shown on Contract Drawings.
b) Door width, height, thickness, type, gage, and options
c) Frame type, width, height, jamb depth, gage, anchor type and options.
d) Door and frame elevations; head and jamb profiles and details; welding requirements; and reinforcements.
e) Fire Rating.
f) Glass type.
g) Undercut.
h) Electric preparations, if any.
i) Hardware Set.
j) Show dimensioned elevations; construction details of each door including vertical and horizontal edge details; and frame details for each type, including dimensions profiles; locations for finish hardware, including cutout & reinforcements; gage of reinforcements; details of connections; anchors and accessories; and details of conduit and preparations for electrified door hardware and controls.

3) Product Data: Manufacturer's catalog sheets, specifications, and detailed installation instructions. Highlight products and options pertaining to this Project. Cross out information irrelevant to this Project.
4) Manufacturer's Written Certification of Compliance that their products conform to the requirements of the references named in the References Article of this specification section, and as modified by this specification.
5) Samples:
a) Frames: One sample of each type, 50cm x 50cm, with mortises and reinforcements, factory primed or factory finished, as required.
b) Doors: One sample of each type construction, 50cm x 50cm, with mortises and reinforcements, factory primed or factory finished, as required.

2. Closeout Submittals: Submit as a complete package.
a. Operation and Maintenance Manuals: Furnish 2 (two) hard cover three ring binders with project name and number prominently displayed on the front cover and the spine.
b. Listing of Manufacturer, address and contact information
c. Approved Door and Frame Submittal including shop drawings and product data sheets

d. Manufacturer's dated warranty, as required by the Engineer, for this specific project identified by Facility, project number, and manufacturer's order number.
e. Certification: Written certification from the Company Field Advisor that their products are installed according to manufacturer's printed installation instructions, and are operating properly.

1.05 QUALITY ASSURANCE

A. Uniformity and single source responsibility:
1. Unless specified or directed otherwise provide metal doors and frames from a single source manufacturer who specializes in this type of work.

B. Certification of Compliance: A statement, written on metal door and frame manufacturer's letterhead, that certifies their products, submitted for this Project, have been tested and comply with references named in the References Article of this specification section, and as modified by other requirements of this specification.

C. Construction Verification: In order to determine if the products furnished comply with the specifications, the Engineer may choose one or more doors and frames for examination. The examination may involve visiting manufacturer's workshop, cutting doors to expose the internal construction to inspect reinforcements, cores, welds and other construction details.

D. Field Measurements: Verify existing openings by field measurements before fabrication and indicate measurements on shop drawings.

E. Pre-Submittal Conference: Before the metal door and frame submittals are written, the contractor, the metal door and frame distributor, the metal door and frame shop drawing preparer, and the metal door and frame designer together with the Engineer Representative shall attend a conference to discuss the contract requirements for the steel door and frame submittal package, including but not limited to, quality assurance items to be submitted, the cover sheet, index, page numbering, schedule formatting, product nomenclature, installation notes, preparation for electric hardware, & product data sheets.

F. Pre-installation Conference: When metal frames are on site, and before metal frame installation begins, the Engineer's Representative shall call a conference at the site to review the approved Metal Door and Frame Submittal, approved Finish Hardware Submittals, and proper installation procedures for the Work as well as:
1. Pre-installation inspection of Doors and Frames
a. Use and coordination of approved Metal Door and Frame submittals with approved Finish Hardware Submittals in the pre- installation inspection process
b. Reading and understanding manufacturer's Door and Frame tags
c. Inspection and verification of labeling and label placement
1) Specified fire labels (attached metal labels) on doors and frames,
2) Label locations
3) Label legibility

d. Inspection and verification of proper welding of frames
e. Inspection and verification of hardware reinforcement and preparations in frame head and jambs.
f. Inspection and verification of required anchors and fasteners.
g. Inspection and verification of glass kit preparations in doors
h. Inspection and verification of Electric hardware preparation in frames & doors

2. Review of maximum allowable clearances between frames and doors; doors and floor; and meeting stiles of doors, and verification methods.
3. Verification of plumb, square and level frame installation with jamb rabbets parallel

to one another.
4. Review of proper frame installation tools.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames in heavy paper cartons or other protective packaging. Remove any plastic protective wrap from the package.

B. Store doors and frames under cover, in a dry area, on raised platforms in vertical position with minimum 10 cm blocking between units to allow air circulation.

C. Clearly label packaging, and doors and frames, for identification and installation location.

PART 2 PRODUCTS

2.01 STEEL MATERIALS

A. General:
1. The grade of materials, properties, ductility and tolerance requirements, fracture toughness, etc., for steel shall comply with the requirements stated in EBSC EN 1993 and/or the following standards, in this section part, as appropriate.

B. Hot Rolled Steel Sheets and Strip:`
1. The structural quality for hot-rolled steel sheet shall comply with ES ISO 4995.
2. Hot-rolled steel sections shall comply with ES ISO 657.
3. The structural quality for hot-rolled steel strip shall comply with ES ISO 6316.
4. Hot rolled carbon strip of commercial and drawing qualities shall comply with ES ISO 6317.

C. Cold Rolled Steel Sheets:
1. The structural quality for cold-reduced steel sheet shall comply with ES ISO 4997.
2. Cold Reduced Carbon Steel Sheet of Commercial and Drawing Qualities, comply with ES ISO 3574.

D. Galvanized Steel Sheets:
1. Continuous Dip Zinc Coated Carbon Steel Sheet of Structural Quality, comply with ES ISO 4998.
2. Continuous Dip Zinc Coated Carbon Steel Sheet of Commercial, Lock-forming, and Drawing Qualities, comply with ES 1268.

E. Metal Door Frames:
1. The material for door frames fabricated from mild steel sheet shall comply with ES 1344.

F. Steel Products:
1. Complying with ES ISO 6929.

G. Fasteners: In general, bolts, screws, studs and nuts shall comply with ES ISO 8992 and/or the followings as appropriate.
1. Tolerances and product grades shall comply with ES ISO 4759-1.
2. Bolts shall comply with ES 2966.

H. Locks and Latches:
1. Comply with ES 2983.

I. Hinges:
1. Comply with the requirements of ES 1344 for hinge type and product to be fixed

with steel door frames.
2. Comply with the requirements of ES 2969 for single axel hinges.

2.02 ALUMINUM MATERIALS

A. General: The materials type for aluminum shall comply with the requirements of ES 3139 and/or the followings as appropriate.
1. The materials type for aluminum shall comply with the requirements of ES 3139.
2. The chemical composition and forms of products for wrought aluminum and aluminum alloys shall comply with ES ISO 209
3. The sheets, strips and plates of wrought aluminum and aluminum alloy shall comply with ES ISO 6361.
4. Tubes and profiles of wrought aluminum and aluminum alloy shall comply with ES ISO 6362.

2.03 DOORS

A. General: Doors shall comply with the requirements of ES 1595 and the following:
1. Construct doors with smooth flush surfaces without visible joints or seams on exposed faces or stile edges, except around glass and louver panels. Continuously weld vertical edges full height of door, grind smooth, and dress to achieve seamless edge. Tack welded, putty filled edges are not acceptable.
2. Reinforce vertical edges by a continuous steel channel as per the requirements.
3. Close top and bottom of horizontal edges with appropriate steel channel spot welded to the inside of the face sheets as per the requirements.
4. Continuously weld the closing end channels to the vertical edge reinforcing channel at all four corners producing a fully welded exterior.
5. Provide appropriate flush steel top and bottoms caps, notched at both ends to fit hinge and lock channels, installed with welds as per the requirements. Grind welds, body fill and finish smooth.
6. Door Edges: Comply with the requirements.

2.04 FRAMES

A. General:
1. Furnish metal frames for doors, transoms, and other openings, as shown, of size and profile as indicated.
a. In the absence of information in the Contract Documents, steel door frames shall comply with the requirements of elevations and sizes indicated in ES 1344. They shall be manufactured from the profiles shown in ES 1344.
b. Internal steel door frames shall be supplied with a base tie.
c. External door frames shall be supplied with a sill.

B. Hinge fixing:
1. Comply with the requirements of ES 1344 for fixing hinges with steel door frames.
a. The outer surface of the hinge leaf fitted to the frame shall not project above the surface of the rebate.

C. Fixing lugs: Unless otherwise specified or shown, comply with the following.
1. Steel door frame: Comply with the requirements of ES 1344 and the following for supplying fixing lugs.
b. Three adjustable corrugated fixing lugs shall be supplied for each jamb.
c. The lugs shall be of mild steel sheet of not less than 1.2 mm nominal thickness.
d. Lugs shall be protected by zinc coating of average minimum thickness not less than 0.002 mm or equivalent.

2.05 FABRICATION

A. Fabricate steel door and frame units to be rigid, neat in appearance, and free from warp, buckle and defects. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To assure proper assembly at Project site, clearly identify items that cannot be permanently factory-assembled before shipment.
   1. Fabricate steel door frame units in accordance with the requirements of ES 1344 unless specified in the Contract Documents otherwise.
      a. Each frame shall consist of two jambs and a head member and, when applicable, a transom and/or a sill.
      b. Where a transom is used the rebate of the transom shall fit flush with the rebate of the door frame.
      c. The base tie of internal frames shall be braced with adjustable base tie to hold the frames rigid during transit and erection.
      d. External door frames shall be fitted with a sill fixed flush to the base of the frame to suit the door frame profile.

B. Except as shown or specified otherwise the door leaves shall suit as defined in ES 1998.

C. Finish Hardware Reinforcements:
   1. Comply with applicable referenced standards.

D. Finish Hardware Preparation:
   1. Factory prepare doors and frames to receive mortised and concealed hardware, including cutouts; reinforcing; drilling and tapping, in accordance with approved Finish Hardware Schedule and templates furnished by hardware manufacturers.
   2. Factory reinforced doors and frames to receive surface applied hardware. Drill and tap for surface applied hardware at project site.

E. Finish Hardware Locations: Locate hardware reinforcements and mortises so hardware locations comply with requirements of applicable referenced standards.

F. Clearances: Fabricate doors for their respective frames as per the manufacturing tolerance limit and shall comply with the requirements of ES 1595.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine substrates, areas and conditions, with installer present under which frames are to be installed for defects that will adversely affect execution and quality of Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Prior to installation adjust and securely brace door frames for squareness, alignment, twist, and plumb complying with the required tolerances.

3.03 INSTALLATION

A. General: Install metal doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings, Specifications and manufacturer's written instructions. Securely anchor sub-framing to supporting structures, plumb and level and properly prepared to receive aluminum doors and frames.

1. Frames: Install frame of size and profile indicated. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set.
   a. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   b. Check plumb, square-ness, and twist of frames as walls are constructed. Adjust as necessary to comply with installation tolerances.
   c. Place frames in position, ensuring the base tie is set at correct height for appropriate finished floor level.
   d. Plumb to ensure frame is upright, square and free from twist.
   e. Fix temporary struts between the jambs to prevent them from bulging inwards due to the weight of the wall or partition.
   f. Care should be taken not to distort the frame during construction.
   g. Build the walls up each side at equal height.
   h. Voids in the back of frame should be filled in solid with mortar as the work proceeds.
   i. The three lugs provided to each side should be spaced not more than 750 mm apart.
   j. Base ties should be removed after masonry has set and before finished floor is laid.

2. Installation Tolerances: Adjust door frames for square-ness, alignment, twist, and plumb by complying with the installation tolerance requirements of the referenced standards.

B. Doors: Fit doors accurately in their frames, with appropriate clearances for jamb and head, between bottom of door and top of threshold, etc., complying with the requirements of the referenced standards.

3.04 PROTECTION

A. Provide protective covering to protect aluminum doors and frames from damage or defacement after erection.

3.05 ADJUSTING AND CLEANING

A. Final Adjustments:
   1. Check and readjust operating hardware items immediately before final inspection.
   2. Leave Work in complete and proper operating condition.
   3. Remove and replace defective work including doors or frames that are warped, bowed, or otherwise unacceptable.

B. Clean foreign materials off metal doors and frames immediately after installation.

3.06 FINAL INSPECTION

A. Upon completion of the project, the Engineer’s representative will schedule a final inspection to verify doors and frames are properly installed and adjusted. The contractor, door and frame installer, and design representative will attend.

B. Upon verification, the design representative will certify in writing components are properly installed and adjusted within referenced tolerances in accordance with this specification. Include this certification in the Close-out Submittals.

END OF SECTION

SECTION 081400

WOOD AND PLASTIC DOORS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Metal Frames: Section 081100.

B. Finish Hardware: Section 087100.

C. Glass and Glazing: Section 088100.

D. Painting: Section 099101.

1.02 REFERENCES

A. EBSC EN 1995-1-(1 & 2):2015: Design of Timber Structures.

B. ES 1998: Internal and External Wood Door-sets, Door Leaves and Frames – Part 1: Specification for Dimensional Requirements.

C. ES 2050: Wood Preservation in Building Construction Part 2: Preventive Structural Measures.

D. ES 1997-1: Glossary of Building and Civil Engineering Terms – General and Miscellaneous – Section 1.3: Parts of Construction Works – Subsections 1.3.5: Doors, Windows and Openings.

E. CP 151: British Standard Code of Practice for Doors and Windows including Frames and Linings. Part 1. Wooden Doors.

F. BS 459: Specification for Match-boarded Wooden Door Leaves for External Use.

G. BS 745: Animal Glue for Wood.

H. BS 1204: Cold-setting Synthetic Resin Adhesives for Constructional Work in Wood (Phenolic and Amino-plastic).

1.03 DEFINITIONS

A. The terms in this section shall comply with the terms and definitions of ES 1997-1 and the following:
   1. Opening: Void in a building element.
   2. Jamb (1): Vertical part of a wall at an opening.
   3. Jamb (2): Vertical side member of a frame of opening lining.
   4. Lining: Dry covering to any internal building surface.
   5. Frame: Surround to a door leaf, window, etc., that enables it to be fixed in position.
   6. Door: Construction for closing an opening, intended primarily for access.
   7. Door frame: Frame in which a door leaf moves.
   8. Door jamb: Vertical side member of a door frame or door lining.

9. Door leaf: Movable part to close a door opening.
10. Door set: Complete unit supplied from a single source consisting of a door frame, door leaf or leaves, essential building hardware and weather strip.
11. Sill: Construction providing a seating for a frame or the lower member of a frame.
12. Transom: Horizontal member dividing an opening or frame of a window or door.
13. Threshold (1): Horizontal member located at the foot of a door frame.
14. Threshold (2): Horizontal part of a wall or floor at the boot of an opening.
15. Mullion: Intermediate vertical member in an opening or frame.
16. Flush door: Door leaf that does not contain any raised or recessed features nor any openings except those which may be required to receive building hardware.
17. Paneled door: Door leave that has stiles, rails and sometimes muntins, framed with the spaces filled with panels.
18. Glazed door: Paneled door in which the panels are of glass or similar material.
19. Plastic door: Door with a door leaf made of plastic glazing sheet material.
20. Ledged door: Unframed door leaf composed of vertical boarding fixed to horizontal ledges.
21. Ledged and braced door: Ledged door with diagonal brace or braces.
22. Framed and ledged door: Door leaf that has stiles and rails framed and filled in on one face with boarding of lesser thickness than the surrounding frame.
23. Framed, ledged and braced door: Framed and ledged door with diagonal brace or braces.
24. Boarding: The solid filling or cladding in a boarded door. When it is tongued and grooved with beaded or V joints, it is known as ‘match-boarding’.
25. Tenon: The end of a member reduced in section to fit into a mortise.
26. Mortise: A hole, usually rectangular, formed in a member to receive a tenon.
27. Muntin: An intermediate framing member, usually vertical, famed into the rails.
28. Veneer: A thin layer of wood of uniform thickness.
29. Rail: A lay framing member framed into the stiles.
30. Stile: One of the side framing members into which the rails are framed.

1.04 SUBMITTALS

A. Shop Drawings: Show details, elevation, and construction for each door type, location and installation requirements for Finish Hardware (including cutouts and reinforcements), and accessory items.
   1. Include a schedule of doors using the same reference numbers for details and openings as those on the Contract Drawings.

B. Product Data: Catalog sheets, specifications, and installation instructions for each type door specified.

C. Samples:
   1. Sample of each door type, with panel (if any).
      a. Factory Finished Doors: Include shop finish on samples.

   2. Plastic Laminate Color Samples: Manufacturer’s standard color, patterns & textures.

D. Quality Control Submittals:
   1. Affidavit required under Quality Assurance Article.

1.05 QUALITY ASSURANCE

A. Certifications: Affidavit by door manufacturer certifying that each door meets the specified requirements and standards.

B. Fire Rated Doors: Carry metal label, fastened on hinge edge with drive screws, indicating fire class/rating certified by an independent testing agency.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Factory Finished Doors: Deliver doors in factory applied plastic bags or heavy paper protective cartons. Mark packaging with sufficient identification to insure proper door location.

B. Comply with manufacturer's storage instructions.

1.07 PROJECT CONDITIONS

A. Environmental Requirements: Do not store doors within the building or install doors until after completion of cast-in-place concrete, masonry, plastering, gypsum board and tile Work, and until after the building has dried out.

PART 2 PRODUCTS

2.01 MATERIALS

A. Timber: Comply with the requirements of EBSC EN 1995-1-(1 & 2):2015.
   1. Exposed Surfaces: As indicated on the Drawings or specified. Furnish matching exposed surface material on both faces and both edges of each door unless otherwise indicated.
   2. Timber shall be thoroughly seasoned to the moisture content appropriate to Work.

B. Plastic Laminate: High pressure decorative laminates complying with applicable Referenced Standards.

C. Adhesive (Glue): Comply with one of the following as appropriate.
   1. Animal glue: Comply with BS 745.
   2. Synthetic resin adhesives: Comply with BS 1204.

D. Preservatives: Shall comply with the requirements of the Referenced Standards.

E. Flashing for exterior doors: Flexible, non-corrosive, sheet metal and shall comply with the requirements of the Referenced Standards.

F. Wood Louvers: Comply with applicable Referenced Standards.

2.02 FABRICATION

A. Door jambs:
   1. Timber door Jambs shall be produced from specified or approved timber.
   2. Door Jambs shall be supplied assembled unless the supply of knock down forms is approved.
   3. Transoms shall be scribed and framed to the iambs with mortise and tenon joints.
   4. Door Jambs shall be rebated as detailed on drawings.
   5. Fan light openings on door Jambs shall be provided as detailed on drawings.
   6. Glazing beads shall be temporarily pinned in position at the time of delivery.

7. Door Jambs shall be notched to receive ironmongery. Notching shall he executed only after the type of ironmongery and notching depth has been determined.
8. Unless approved, door Jamb shall be produced from full width timber and to the finished wall thickness. The minimum unrebated jamb thickness shall be 40 mm. Lists to cover joints between frame and wall on either face of frame, shall be milled timber molded architrave not less than 50mm wide.
9. Assembled door frames shall have temporary diagonals and stretchers.
10. Door frames shall be screwed to milled timber grounds embedded in masonry. The spacing of ground for jambs and heads shall not be more than 1000 mm centers.
11. Door frames may alternately be fixed using steel band cramps screwed or nailed to the back of the frames and embedded in masonry. The distance between cramps shall not exceed 1000 mm centers.

B. Glazed panel doors:
1. Glazed wood doors shall be produced from specified or approved timber.
2. Glazed wooden doors shall be supplied and assembled unless supply in knock down form is approved.
3. All framing joints should be properly made.
4. Doors shall be produced as detailed on drawings. The side, top, bottom and intermediate rails shall be mortised and tenoned.
5. Rails shall he produced from single width timber. Unless provided otherwise on drawings, the unrebated sizes of rails shall not be less than 40mm thick and l00mm wide or such width required to insert locks.
6. Doors shall be rebated and notched for ironmongery. Notches on doors shall not extend beyond 10mm of the edge of the panel. If the ironmongery requires notching beyond this limit, flat metal lining shall be provided to the inner faces of the notched part in the depth and length of notching.
7. Notches shall be formed only after ironmongery has been examined and trial fitted on sample door.
8. Doors shall be rebated for glazing and beads temporarily pinned to the doors.
9. Doors shall be hinged to frames at locations showing in schedules.

C. Match boarded doors: the types of match boarded doors can be classified as framed door (‘framed and ledged’ or ‘framed, ledged and braced’) or unframed door (‘ledged’ or ‘ledged and braced’) or paneled and shall comply with the following requirements:
1. Comply with BS 459 for the requirements of door leaves for external use.
2. Comply with applicable Referenced Standards and the following in general:
    a. Match boarded doors shall be produced from specified or approved timber.
    b. Match boarded doors shall be supplied and assembled. Doors shall be produced as detailed on drawings. The sides, top, bottom and intermediate rails of match boarded doors shall be mortised and tenoned.
    c. Rails shall be produced from single width timber. Unless provided otherwise on drawings, the unrebated sizes of rails shall not be less than 40mm thick and 100mm width or such width required to insert locks.
    d. Match board panels shall be tongued and grooved boards not less than 20mm thickness and 80mm width. The panels shall be tightly and neatly tongued and grooved & securely glued or secretly nailed to grooves in the intermediate rails.

D. Flush wood doors:
1. Flush wood doors for external use shall be produced from specified or approved tongued and grooved timber. Flush wood doors for internal use shall be produced from timber or panel hoards.

2. The type of panel boards shall be as shown in schedules or approved.
3. The finished thickness of flush doors shall not be less than 40mm.
4. Face panels on either side shall not be less than 150mm wide and 15mm thick.
5. Cores may alternately be formed in honey comb plywood of thickness not less than 4mm.
6. The panel boards shall be securely glued to the core.
7. Tongued and grooved timber if used, shall be neatly and tightly nailed to the core. All outer edges of doors shall be lipped with milled timber to the width of the door and showing not less than 10mm on face.
8. Doors shall be rebated and notched for ironmongery. Notches on doors shall not extend beyond 10mm of the edge of the panel. If the ironmongery requires notching beyond this limit, flat metal lining shall he provided to the inner faces of the notched part in the depth and length of notching.
9. Notches shall be formed only after ironmongery has been examined and trial fitting on sample door.
10. Doors shall be rebated for glazing and heads temporarily pinned to the doors.
11. Doors shall be hinged to frames at locations showing in schedules.

E. Interior plastic faced flush wood doors: Unless specified in the Contract Documents, use factory applied plastic laminate faces with hardwood cross-banding over a solid glued wood block (stave) core edge bonded to stiles and rails, complying with applicable Standards.
   1. Plastic Laminate: Color, pattern, and texture as selected.
   2. Factory applied plastic laminate on both vertical stile edges. Match face laminate.
   3. Manufacturer's standard close grain hardwood on both vertical stile edges, for paint finish.
   4. Light and Louver Beads: Manufacturer's factory applied units of close grain hardwood finished to match face laminate.
   5. Factory fabricate and pre-fit doors to finished size including required clearances. Pre-machine doors for mortise hardware and other required cutting of doors.
      a. Comply with finish hardware schedule, door frame shop drawings and with hardware templates required to insure proper fit and alignment of hardware.

F. Transom and Side Panels:
   1. Panels of identical quality and appearance as associated wood doors where panels are indicated in the same framing system as wood doors.

2.03 PREPARATION FOR PAINTING OR POLISHING

A. Surface for painting shall be cross-sanded.
   1. For staining or polishing, they should be sanded in the direction of the grain.

B. All knots that will be exposed when the door and frame have been fixed should be treated with knotting, and the whole, including the edges of the doors, primed in accordance with the requirements of the Referenced Standards.

C. Factory priming for doors to receive paint finish:
   1. Shop apply prime coat on all exposed surfaces and edges of wood doors scheduled or indicated to receive paint finish as indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Condition doors to average prevailing humidity in installation area prior to hanging.

B. The bottom of frames and linings should be properly protected from damp.

C. Prepare doors to receive scheduled mortise hardware. Coordinate doors with the finish hardware schedule and with the door frame shop drawings for proper location of mortise hardware. Machine doors for hardware.

D. Exterior Doors: Brush coat surfaces of cutouts and surfaces which have been trimmed or altered after fabrication with a compatible preservative.

E. Touch-up cut surfaces of factory primed doors with primer compatible with primer specified for factory priming.

3.02 INSTALLATION

A. Install the Work of this Section in accordance with manufacturer's printed installation instructions and as per the requirements of the Referenced Standards, except as shown or specified otherwise.

B. Fit doors to prepared frames for proper fit. Allow appropriate clearance at head and both jambs. Trim doors when necessary by planning. Slightly chamfer edge of lock stiles.

C. Pre-fit Doors: Do not alter pre-fit factory finished doors.

D. Fire Rated Doors: Install doors in corresponding fire rated frames in accordance with the requirements of the Referenced Standards.

E. All hinges, running gears and other moveable parts of ironmongery, especially for hanging of doors, should be oiled and greased where necessary.

F. Factory finished doors: Field touch-up and restore finishes damaged during installation.

END OF SECTION

Ministry of Construction

SECTION 084413

GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Structural Metal Framing: Section 051000.

B. Joint Sealants: Section 079200.

C. Metal Windows: Section 085100.

D. Glass and Glazing: Section 088100.

1.02 REFERENCES

A. ES 3140: Code of Practice for Design of Non-Loadbearing External Vertical Enclosures of Buildings.

B. ES 3161: Curtain Walling - Resistance to Wind Load - Performance Requirements.

C. ES 3211: Curtain Walling - Air Permeability - Performance Requirements and Classification.

D. ES 3212: Curtain Walling - Air Permeability - Test Method.

E. ES 3213: Curtain Walling – Water-tightness - Performance Requirements and Classification.

F. ES 3214: Curtain Walling – Water-tightness - Laboratory Test under Static Pressure.

G. ES 3224: Curtain Walling – Water-tightness - Site Test.

H. ES 3308: Curtain Walling - Resistance to Wind Load -Test Method.

I. ES 3139: Structural Use of Aluminum – Part 1. Code of Practice for Design.

J. ES 2961: Building Hardware – Gasket and Weather-stripping for Doors, Windows, Shutters and Curtain Walling – Part 1: Performance Requirements and Classification.

K. BS 5516: Code of Practice for Design and Installation of Sloping and Vertical Patent Glazing.

L. BS 6100:1.3.1: Glossary for Building and Civil Engineering Terms – Part 1. General and Miscellaneous – Section 1.3 Parts of Construction Works – Subsection 1.3.1 Walls and Cladding.

M. BS 6100:1.4.1: Glossary for Building and Civil Engineering Terms – Part 1. General and Miscellaneous – Section 1.4 Materials – Subsection 1.4.1 Glazing.

1.03 DEFINITIONS

A. The terms in this Section shall comply with the terms and definitions stated in BS 6100:1.3.1, BS 6100:1.4.1 and the following.
   1. Cladding: External, vertical or near vertical non-loadbearing covering to a structure.
   2. Curtain wall: Non-loadbearing wall positioned on the outside of a building and enclosing it.
   3. Glazing: Fixing infill of plastic glazing sheet or glass.
   4. Infill: Assembly of single or composite materials which is inserted to form part of the structure of a façade, panel or frame in order to fill any gaps or openings.
   5. Patent glazing: A self-draining and ventilated system of dry glazing which does not rely necessarily for its water-tightness upon external glazing seals. It consists essentially of a series of longitudinal supporting members, i.e. patent glazing bars and an infilling of glass or other suitable infilling material.
   6. Patent glazing bar: Longitudinal supporting member in a patent glazing that spans between structural members and incorporates water channels.
   7. Stud: Vertical member in a framed wall.

1.04 SYSTEMS DESCRIPTION

A. Curtain wall system: includes thermally broken tubular aluminum sections with supplementary support framing, shop fabricated, factory prefinished, vision glass, insulated metal panel, spandrel infill, column covers, related flashings, anchorage and attachment devices.

B. Assemble system to permit re-glazing of individual glass (and infill panel) units without requiring removal of structural mullion sections.

C. No curtain wall framing member shall deflect, in a direction normal to plane of wall, more than the required limit.

D. Provide system complete with framing, mullions, trim, fasteners, anchors, accessories, concealed auxiliary members, and attachment devices for securing wall to structure as specified or indicated.

E. Fully coordinate system accessories directly incorporated and adjacent to contiguous related work and insure materials compatibility, deflection limitations, thermal movements, and clearances and tolerances as indicated or specified.

F. Provide system with adequate allowances for expansion and contraction of components and fastenings to prevent buckling damage, joint seal failure, glass breakage, and undue stress on fastenings or other detrimental effects.

G. Provide wall system to accommodate tolerances in building frame and other contiguous work as indicated or specified.

1.05 DESIGH REQUIREMENTS

A. Unless specified otherwise, glazed aluminum curtain walls shall be designed in accordance with the requirements of ES 3140.

1. The design shall satisfy the testing requirements of curtain walling stated in applicable Referenced Standards.
2. The design shall include construction details for cleaning and maintenance of curtain walls.
    a. The design shall consider the safely of the workers performing cleaning and maintenance works of curtain walls.

3. The design shall consider the glare effect of the curtain walls created by the reflection of sunlight to be within permissible range as required by applicable Referenced Standards and Regulatory Requirements.
4. Consider the design requirements of BS 5516 for patent glazing.

1.06 PERFORMANCE REQUIREMENTS

A. System shall meet or exceed all performance requirements specified in ES 3140 and other Referenced Standards for Curtain Walling.

B. Curtain wall components shall have been tested in accordance with requirements of applicable Referenced Standards and shall meet performance requirements specified.

C. System Design: Design and size components to withstand dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall.

D. Seismic Loads: Design and size components to withstand seismic loads and sway displacement.

1.07 SUBMITTALS

A. Manufacturer's Literature and Product Data: Submit product data, samples, all the items listed under Quality Control Submittals, and any proposed deviations from the Contract Documents, at the same time as one complete package. Partial submittals will not be considered unless specified or permitted by the Engineer.
    1. Proposed Deviations from The Contract Documents: To be considered for approval, proposed deviations must be submitted with the initial submittal package. Proposed deviations submitted after the initial submittals package is approved will not be considered or approved and may be cause for rejection of the previously approved manufacturer or system.
    2. Product Data: Catalog sheets, specifications, load tables, and installation instructions for each material specified.
        a. Contract Documents: Unless approved otherwise, the Contract Documents have precedence over manufacturer’s details and specifications except when a specific detail or condition is not addressed in the Contract Documents.
        b. Manufacturer’s Details: Do not use or submit manufacturer’s details unless there is an omission or proposed deviation from the Contract Documents. In such instances, submit the proposed detail for approval. The proposed detail shall be referenced directly to the related detail on the Contract Drawings.
        c. Manufacturer’s Specifications: When there is a proposed deviation from the Specifications of the Contract Documents, submit the proposed deviation for approval. The proposed deviation shall be referenced directly to the related article in the Contract Specifications.

B. Samples:

1. Submit pairs of samples of each specified color and finish on 300 mm (12-inch) long section by width of each tubular or extruded shape section or 300 mm by 300 mm (12-inch by 12-inch) wide sections of sheet shapes.
2. Submit corner section of framing members showing fasteners, panels, glazing methods, glazing materials, and weather-stripping. Submit one sample minimum 300 mm by 300 mm (12 inches by 12 inches). In lieu of submitting separate samples for corner section, intermediate section, and panel, one composite sample incorporating all components and features listed may be submitted.
3. Where normal color variations are anticipated, include 2 or more units in set indicating extreme limits of color variations.

C. Shop Drawings:
1. Show elevations of glazed curtain wall system at 1:50 (1/4 inch) scale, metal gages, details of construction, methods of anchorage, glazing details, and details of installation.
2. Submit for curtain wall system, accessories, and mock-up. Tentative approval of drawings shall be received before fabrication of mock-up. Final approval of drawings shall be deferred pending approval of mock-up and accessories. Drawings shall indicate in detail all system parts including elevations, full size sections, framing, jointing, panels, types and thickness of metal anchorage details, flashing and coping details, field connections, weep and drainage system, finishes, sealing methods, glazing, glass sizes and details, fire-stopping insulation materials, and erection details.
3. Operation and Maintenance Manuals:
   a. Submit cleaning and maintenance instructions.

D. Glass:
1. Specified in Section 088100, Glass and Glazing.

E. Quality Control Submittals:
1. Design Data:
   a. Submit structural and thermal calculations for complete wall assembly. Structural calculations and design shop drawings shall be signed and sealed by a professional structural engineer registered and licensed by recognized authority.

2. Factory Test Reports:
   a. Test Reports: Provide certified test reports, for each of following listed tests, from a qualified independent testing laboratory showing that glazed aluminum curtain wall system assembly has been tested in accordance with specified test procedures and complies with performance characteristics as indicated by manufacturer's testing procedures. Manufacturer shall submit appropriate testing numbers for specific tests indicated below.
      1) Deflection and structural tests.
      2) Water penetration tests.
      3) Air infiltration tests.
      4) Delamination tests.
      5) Thermal conductance tests.
      6) Sound transmission loss test.
      7) Submit factory tests required except that where a curtain wall system or component of similar type, size, and design as specified for this project has

been previously tested within last year, under conditions specified herein, resulting test reports may be submitted in lieu of listed testing.

F. Manufacturer's Certificates:
   1. Submit Certificates of Compliance, with specification requirements, for the following.
      a. Metal extrusions.
      b. Metal accessories.
      c. Stating that aluminum has been given specified thickness of anodizing or organic coating finish.
      d. Indicating manufacturer's and installer's meet qualifications as specified.
      e. Submit list of equivalent size installations, for both manufacturer and installer, which have had satisfactory and efficient operation.

G. Manufacturer's Field Reports:
   1. Submit field reports of manufacturer's field representative observations of curtain wall installation indicating observations made during inspection at beginning of project, during middle of installation and at conclusion of project. Indicate results of field testing of mockup field panel, and any directions given Contractor for corrective action.

1.08 QUALITY ASSURANCE

A. Qualifications:
   1. Approval is required of products or service of proposed manufacturer, suppliers and installers, and will be based upon submission by Contractor of certification that:
      a. Manufacturers Qualifications: Manufacturer with five (5) years continuous documented experience in design, fabrication, and/or installation of glazed aluminum curtain wall systems of type and size required for that project.
      b. Installer: Manufacturer approved in writing. Continuously installed glazed aluminum curtain walls systems for previous five (5) years.
      c. Manufacturer shall provide technical field representation at project site, as a minimum, at start of project, during middle, towards end of project, and during field testing of field mockup panel.
      d. Testing Laboratory: Contractor retained. Engage an accredited commercial testing laboratory to perform tests specified as required by the Engineer. Submit information regarding testing laboratory's facilities and qualifications of technical personnel to perform testing specified in this section.
      e. Qualification of Welders: Welding shall be performed by certified welders qualified in accordance with applicable Referenced Standards, using procedures, materials, and equipment of the type required for this work.

B. Pre-Installation Conference: Prior to starting installation of glazed curtain wall system, schedule conference with Engineer's Representative at the site to ensure following:
   1. Clear understanding of drawings and specifications.
   2. Onsite inspection and acceptance of structural and pertinent structural details relating to curtain wall system.
   3. Coordination of work of various trades involved in providing system. Conference shall be attended by Contractor; personnel directly responsible for installation of curtain wall system, flashing and sheet metal work, fire-stopping system and curtain wall manufacturer and their Technical Field Representatives. Conflicts shall be resolved and confirmed in writing.

4. The conference shall be attended by the Contractor, the authorized system installer, the person supervising the Work, the job foreman or crew chief, and the designer.
5. The Engineer's Representative chairs the conference.

C. Mockup: Perform the following fully or partially in addition to or/and as required by the Contract Documents, or as directed by the Engineer.
1. Construct, at job site, full size typical wall unit which incorporates horizontal and vertical joints, framing, window units, panels, glazing, sealants, and other accessories as detailed and specified. Mock-up wall unit location, size and design shall be as indicated. Orient mockup to be facing full sun when constructed.
2. Performance Test:
a. Conduct performance test after approval of visual aspects has been obtained. Finished work shall match approved mock-up.
b. Refer to the requirements for testing included in this Section of Specification or applicable Referenced Standards.

3. Approved Mock-up:
a. After completion and approval of test results of job site mockup, as directed, approved mock-up panel shall be used as minimum standard of comparison for entire curtain wall system.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Comply with the requirements for delivery, storage and handling of materials and components stated in applicable Referenced Standards.

B. Prior to packaging for shipment from factory, mark wall components to correspond with shop and erection drawings and their placement location and erection.

C. Prior to shipment from factory, place knocked-down lineal members in cardboard containers and cover finished surfaces of members with protective covering of adhesive paper, waterproof tape, or strippable plastic. Do not cover metal surfaces that will be in contact with sealants after installation.

D. Inspect materials delivered to site for damage; unload and store with ventilation, free from heavy dust, not subject to combustion products or sources of water, and shall permit easy access for inspection and handling.

1.10 PROJECT CONDITIONS

A. Unless directed otherwise, do not execute the Work of this Section unless the Engineer's Representative is present.

B. Do not install the Work of this Section unless the substrate is dry and free of dirt and debris.

C. Field Measurements:
1. Where glazed aluminum curtain wall systems are 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 Work.

1.11 WARRANTY

A. Provide a written guarantee in the name of the owner stating that the curtain wall system; including but not limited to frames, glazing, panels, flashings, etc., is guaranteed against material and workmanship for a period for ten (10) years from the date of Substantial Completion.

1.12 MAINTENANCE

A. Provide maintenance manual for cleaning and maintenance of Glazed Aluminum Wall and finishes.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Type of materials for glazed curtain wall components shall comply with the requirements specified in this Section hereunder of specifications unless clearly indicated in the Contract Documents.

B. Aluminum Framing Members and sheet:
   1. Comply with the requirements of ES 3139.
   2. Size and color: As indicated.

C. Glazing Materials:
   1. As specified under Section 088100 Glass and Glazing.
   2. Glazing Gaskets: Comply with the requirements of ES 2961.
   3. Glass Sizes and Clearances:
      a. Size: As indicated.
         1) Verify actual sizes required by measuring frames.

      b. Clearances:
         1) Coordinate dimensions for glass and glass holding members to meet applicable minimum clearances as per applicable Referenced Standards or as recommended by glass manufacturer.

      c. Do not nip glass to remove flares or to reduce oversized dimensions. All cutting shall occur in factory.

   4. Glass Setting Materials:
      a. Provide head bead and drive wedge required for glass installation to suit curtain wall system in accordance with the requirements of applicable Referenced Standards or manufacture’s recommendations.

D. Steel Sections:
   1. As indicated.

E. Patent glazing system:
   1. General: All materials and components shall be of aluminum type and shall fulfill the requirements of BS 5516. Materials and components include:
      a. Patent glazing bar, bars, wings and sheaths.

b. Transverse supporting members: Head, sills and transoms.

F. Primer:
1. Comply with applicable Referenced Standards

G. Joint Sealants and Accessories:
1. In accordance with requirements specified in Section 079200, Joint Sealants.
2. Comply with recommendations of sealant manufacturer for specific sealant selections.
3. Provide only sealants that have been tested as per the requirements of applicable Referenced Standards and approved by the Engineer's Representative to exhibit adequate adhesion to samples of glass and metal equivalent to those required for project.

H. Fasteners:
1. Comply with applicable Referenced Standards.

2.02 FABRICATION

A. Curtain wall components
1. Shall be of materials and thickness indicated or specified. Details indicated are representative of required design and profiles.
2. Maintain sightlines indicated on drawings. Unless specifically indicated or specified otherwise, methods of fabrication and assembly shall be in accordance with applicable Referenced Standards.
3. Perform fitting and assembling of components in shop to maximum extent practicable. Anchorage devices shall permit adjustment in three directions. There shall be no exposed fasteners.

B. Protection and Treatment of Metals:
1. Remove from metal surfaces lubricants used in fabrication and clean off other extraneous material before leaving shop.

C. Metal sills and Closures:
1. Fabricate accessories, spandrel panels, trim closures of sizes and shapes indicated from similar materials and finish as specified for wall system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to installation of glazed curtain wall system, arrange for representative(s) of manufacturer to examine structure and substrate to determine that they are properly prepared, and ready to receive glazed curtain wall work included herein.

B. Verifying Conditions and Adjacent Surfaces:
1. After establishment of lines and grades and prior to system installation examine supporting structural elements. Verify governing dimensions, including floor elevations, floor to floor heights, minimum clearances between curtain wall and structural frames, and other permissible dimensional tolerances in building frame.

3.02 PREPARATION

A. Take field dimensions and examine condition of substrates, supports, and other conditions under which work of this section is to be performed to verify that work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Contact between aluminum and dissimilar metals shall receive a protective coating of approved type [for example asphaltic paint] for prevention of electrolytic action and corrosion.

3.03 INSTALLATION

A. Installation and erection of glazed curtain wall system and all components shall be in accordance with the Contract Documents, the approved shop drawings and approved deviations (if any) from the Contract Documents. In the absence of detail for installation and erection of glazed curtain wall, comply with applicable Referenced Standards.
   1. Coordinate the installation of the glazed curtain wall system with other Work of the Contract.
   2. Install the Work of this Section so the system is secure, watertight, plumb, and straight and true to adjacent work.
   3. Exposed metal shall be free of visible dents, scratches, tool marks, cuts, and other imperfections.

B. Bench Marks and Reference Points:
   1. Establish and permanently mark bench marks for elevations and building line offsets for alignment at convenient points on each floor level. Should any error or discrepancy be discovered in location of marks, stop erection work in that area until discrepancies have been corrected.

C. Install glazed aluminum curtain wall system so as to maintain a virtually flat face cap, with no visible bowing.

D. Installing Composite Vapor Retarder / Slip Sheet:
   1. On steel decks the vapor retarder must be installed the same day the underlayment board is installed.
   2. Unprotected underlayment board will not be allowed.

E. Install entire system so that fasteners are not visible.

F. Tolerances:
   1. As indicated, if not comply with applicable Referenced Standards.

G. Windows:
   1. Refer to Section 085100, Metal Windows, for aluminum window requirements.
   2. Install windows in accordance with details indicated and approved shop drawing detail drawings.
   3. Seal exterior metal to metal joints between members of windows, frames, mullions, and mullion covers in accordance with requirements of Section 079200, Joint Sealers. Remove excess sealant.

4. After installing and glazing windows, adjust ventilators and hardware to operate smoothly and to be weather-tight when ventilators are closed and locked. Lubricate hardware and moving parts.
5. Install to make weather-tight contact with frames when ventilators are closed and locked. Do not cause binding of sash or prevent closing and locking of ventilator.
    a. Provide for ventilating sections of all windows to insure a weather-tight seal meeting infiltration tests specified.
    b. Use easily replaceable factory-applied weather-stripping of approved manufacturer's stock type.

H. Joint Sealants:
1. Joint Sealants: Shall be in accordance with requirements of Section 079200, Joint Sealants.
2. Surfaces to be primed and sealed shall be clean, dry to touch, free from frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter. Enclose joints on three sides. Clean out grooves to proper depth. Joint dimensions shall conform to approved detail drawings with a required tolerance requirement. Apply compound during convenient atmospheric conditions complying with the ambient temperature requirements of applicable Referenced Standards. Clean out loose particles and mortar just before sealing. Remove protective coatings or coverings from surfaces in contact with sealants before applying sealants or tapes. Solvents used to remove coatings shall be of type that leaves no residue on metals.
3. Match approved sample. Force compound into grooves with sufficient pressure to fill grooves solidly. Sealing compound shall be uniformly smooth and free of wrinkles and, unless indicated otherwise, shall be tooled and left sufficiently convex to result in a flush joint when dry. Do not trim edges of sealing material after joints are tooled.

I. Glass:
1. Refer to Section 088100, Glass and Glazing, and Contract Drawing for glass types.
2. Install in accordance with the Contract Documents and approved deviations (if any) from the Contract Documents. In the absence of detail for installation of glass, comply with applicable Referenced Standards.
3. Before installing glass, inspect sash and frames to receive glass for defects such as dimensional variations, glass clearances, open joints, or other conditions that will prevent satisfactory glass installation. Do not proceed with installation until defects have been corrected.
4. Clean sealing surfaces at perimeter of glass and sealing surfaces of rebates and stop beads before applying glazing compound, sealing compound, glazing tape, or gaskets. Use only approved solvents and cleaning agents recommended by compound or gasket manufacturer. All sashes shall be designed for outside glazing. Provide continuous snap in glazing beads to suit glass as specified.
5. Provide adequate means to weep incidental water and condensation away from sealed edges of insulated glass units and out of wall system.

3.04 ADJUSTING

A. Adjust windows, doors or revolving doors to provide a tight fit at contact points and operate easily.

B. Adjust weather-stripping to make even contact with surfaces.

C. Adjust operating hardware and moving parts.

3.05 CLEANING

A. Install curtain wall frame and associated metal to avoid soiling or smudging finish.

B. Clean metal surfaces promptly after installation, exercising care to avoid damage to coatings.

C. Remove excess glazing and sealant compounds, dirt, and other substances.

D. Follow recommendations of manufacturer in selection of cleaning agents. Do not use cleaning agents containing ammonia or other compounds that might damage finished metal surfaces.

E. Replace cracked, broken, and defective glass with new glass at no additional cost to Procuring Entity. Just prior to final acceptance of curtain wall system clean glass surfaces on both sides, remove labels, paint spots, compounds, and other defacements, and clean metal fixed panels. Remove and replace components that cannot be cleaned successfully.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Engage accredited commercial qualified independent testing and inspecting agency to perform field quality-control tests specified, and to prepare test reports: Submit information regarding testing laboratory's facilities and qualifications of technical personnel to Engineer’s Representative for approval.

B. Conduct field check test for glazed aluminum curtain wall system for those performance requirements indicated and required by the Engineer’s Representative for compliance with the requirements of applicable Referenced Standards.

3.07 PROTECTION

A. After installation, protect windows, and other exposed surfaces from disfiguration, contamination, contact with harmful materials, and from other construction hazards that will interfere with their operation, or damage their appearance or finish. Protection methods shall be in accordance with recommendations of product manufacturers or of applicable Referenced Standards. Remove paper or tape factory applied protection immediately after installation. Clean surfaces of mortar, plaster, paint, smears of sealants, and other foreign matter to present neat appearance and prevent fouling of operation. In addition, wash with a stiff fiber brush, soap and water, and thoroughly rinse. Where surfaces become stained or discolored, clean or restore finish in accordance with recommendations of product manufacturer or applicable Referenced Standards.

END OF SECTION

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Ministry of Construction

SECTION 085100

METAL WINDOWS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Joint Sealers: Section 079200.

B. Glass and Glazing: Section 088100.

C. Field Painting: Section 099101.

1.02 REFERENCES

A. EBSC EN 1993:2015: Design of Steel Structures.

B. ES 1566: Performance of Windows. Classification for Weather Tightness (Including Guidance on Selection and Specification).

C. ES 1595: Specification for Steel Windows, Sills, Window Boards and Doors.

D. ES ISO 630-1: Structural Steels – Plates, Wide Flats, Bars, Sections and Profiles.

E. ES ISO 630-2: Structural Steels – Part 2: Technical Delivery Requirements for Hot-Finished Hollow Sections.

F. ES ISO 6929: Steel Products – Definitions and Classification.

G. ES ISO 4995: Hot-Rolled Steel Sheet of Structural Quality.

H. ES ISO 4997: Cold-Reduced Steel Sheet of Structural Quality.

I. ES ISO 6316: Hot-Rolled Steel Strip of Structural Quality.

J. ES ISO 4998: Continuous Dip Zinc Coated Carbon Steel Sheet of Structural Quality.

K. ES ISO 657: Hot-Rolled Steel Sections.

L. ES ISO 9328-1: Steel Flat Products for Pressure Purposes – Technical Delivery Conditions Part 1: General Requirements.

M. ES ISO 9328-2: Steel Flat Products for Pressure Purposes – Technical Delivery Conditions Part 2: Non-Alloy and Alloy Steels with Specified Elevated Temperature Properties.

N. ES 2947: Building Hardware Cylinder for Locks – Requirements and Test Methods.

O. ES 2966: Building Hardware – Door and Window Bolts – Requirements and Test Methods.

P. ES 2969: Building Hardware – Single Axis Hinges – Requirements and Test Methods.

Q. ES 2983: Building Hardware – Locks and latches – Mechanically Operated Locks, Latches, and Locking Plates – Requirements and Test Methods.

R. ES 1997-1: Glossary of Building and Civil Engineering Terms – General and Miscellaneous – Section 1.3: Parts of Construction Works – Subsections 1.3.5: Doors, Windows and Openings.

S. ES 3139: Structural Use of Aluminum – Part 1: Code of Practice for Design.

T. ES ISO 209: Wrought Aluminum and Aluminum Alloys – Chemical Composition and Forms of Products.

U. ES ISO 6361: Wrought Aluminum and Aluminum Alloy Sheets, Strips and Plates.

V. ES ISO 6362: Wrought Aluminum and Aluminum Alloy Extruded Rods/ Bars, Tubes and Profiles.

1.03 DEFINITIONS

A. The terms in this section shall comply with the terms and definitions of ES 1997-1 and the following:
   1. Window: Construction for closing a vertical or near vertical opening in a wall or pitched roof that will admit light and may admit fresh air.
   2. Opening: Void in a building element.
   3. Jamb (1): Vertical part of a wall at an opening.
   4. Jamb (2): Vertical side member of a frame of opening lining.
   5. Lining: Dry covering to any internal building surface.
   6. Frame: Surround to a door leaf, window, etc., that enables it to be fixed in position.
   7. Window frame: Frame that contains the lights of a window.
   8. Transom: Horizontal member dividing an opening or frame of a window.
   9. Mullion: Intermediate vertical member in an opening or frame.
   10. Window jamb: Vertical side member of a window frame or window lining.
   11. Light: Individual glazed unit of a window.
   12. Sash: Framed opening light that slides.
   13. Sill: Construction providing a seating for a frame or the lower member of a frame.
   14. Head: Top member, usually horizontal, of a frame or opening lining.

1.04 DESCRIPTION

A. Window Classification:
   1. Weather Tightness: Complying with ES 1566.
   2. Bullet Resistance: Complying with ES 3228.
   3. Explosion Resistance: Complying with ES 3202.
   4. Mechanical Durability: Complying with ES 2985.

1.05 PERFORMANCE REQUIREMENTS

A. Wind Resistance Test: Complying with ES ISO 6612.

B. Air Permeability Test: Complying with ES ISO 6613.

C. Thermal Performance: Complying with ES ISO 12567-1.

D. Structural Performance: Complying with ES ISO 630-1 & ES ISO 630-2.

1.06 SUBMITTALS

A. Shop Drawings: Furnish for each type window included in project.
   1. Layout and installation details, including anchors, support framing and sheet metal trim members.
   2. Elevations of continuous work and typical window unit elevations as per the standard scale.
   3. Full-size section details of typical composite members, including reinforcement.
   4. Hardware.
   5. Accessories.
   6. Glazing details.
   7. Color charts for standard finishes and sealants.

B. Product Data: Furnish for each type of window required, including:
   1. Construction details and fabrication methods.
   2. Profiles and dimensions of individual components.
   3. Data on hardware, including sweep lock, keeper, lift handles, accessories, and finishes.
   4. Recommendations for maintenance and cleaning of window surfaces.

C. Samples:
   1. Corner section of frame, sash, etc. showing materials and construction.
   2. One window unit of each type.
   3. Hardware: Each item required.
   4. Color Samples for Factory Prefinished Windows: Manufacturer's standard colors for specified finish.

D. Quality Control Submittals:
   1. Test Reports: Window manufacturer provide certified test report from a qualified independent testing laboratory engaged in testing windows to verify that his metal window assembly has been tested in accordance with specified test procedures and products comply with these minimum test performance characteristics indicated. Test reports shall have been made within current year.
   2. Manufacturer’s Certificate:
      a. Stating metal members have been given specified thickness of prime coat and/or organic coating finish.
      b. Indicating manufacturer and installer’s meet qualifications as specified.

E. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, including instructions for cleaning and touching-up finish, to the Engineer's Representative.

1.07 QUALITY ASSURANCE

B. Testing Agency:
   1. Wind resistance, air permeability, thermal and structural performance tests shall be performed by a qualified independent testing laboratory.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver metal window units and related components in manufacturer's original, unopened protective packaging labeled for identification with manufacturer's name and brand and contents. Use padded blankets or other approved protective wrapping for glass, decorative metal work, and other exposed elements.
   1. Do not deliver metal window units until work is ready for their installation.
   2. Inspect components for damage upon delivery. Do not install metal window units with dimples or dents. Remove and replace damaged components at no additional cost.

B. Store metal window units and related components, in positions necessary to prevent twisting, in weather-tight and dry storage facility in their original shipping containers with protective wrapping or packaging securely in place, in accordance with manufacturers written instructions.

C. Protect finish from damage from handling, weather and construction operations before, during and after installation.

1.09 WARRANTY

A. Warranty: Submit written warranty, in accordance with the Contract Requirements.

PART 2 PRODUCTS

2.01 STEEL MATERIALS

A. Windows and Frames: Unless otherwise shown or specified, the grade of materials, properties, ductility and tolerance requirements, fracture toughness, etc., for steel windows shall comply with the requirements stated in EBSC EN 1993:2015 and/or the following standard requirements as appropriate.
   1. Hot Rolled Steel Sheets and Strip:
      a. The structural quality for hot-rolled steel sheet shall comply with ES ISO 4995.
      b. Hot-rolled steel sections shall comply with ES ISO 657.
      c. The structural quality for hot-rolled steel strip shall comply with ES ISO 6316.

   2. Cold Rolled Steel Sheets:

      a. The structural quality for cold-reduced steel sheet shall comply with ES ISO 4997.

   3. Galvanized Steel Sheets:
      a. The structural quality for continuous dip zinc coated carbon steel sheet shall comply with ES ISO 4998.

B. Glazing Beads: Unless otherwise shown or specified, comply with the requirements of the Referenced Standards.
   1. Finish: Finish shall match windows.

C. Hardware:
   1. Lever Handles and Knob Furniture: complying with ES 3004.

2. Locks and Latches: complying with ES 2983.

D. Weather-stripping: Complying with ES 1566.

E. Mullions and Transom Bars: Unless otherwise shown or specified, comply with the requirements of the Referenced Standards.

F. Locks and Latches:
1. Comply with ES 2983.

G. Hinges:
1. Comply with the requirements of appropriate Referenced Standards for hinge type and product to be fixed with steel door frames.
2. Comply with the requirements of ES 2969 for single axel hinges.

H. Accessories:
1. Anchors: Anchors, clips, fittings, and related fasteners shall be galvanized or cadmium plated steel, unless otherwise approved.
2. Fasteners: In general, bolts, screws, studs and nuts shall comply with ES ISO 8992 and/or appropriate Referenced Standards as appropriate.

I. Sealing Mastic: Non-staining sealant material of approved quality and recommended by window manufacturer.

2.02 ALUMINUM MATERIALS

A. General: The materials type for aluminum window shall comply with the requirements of ES 3139:2006 and/or the followings as appropriate.
1. The materials type for aluminum shall comply with the requirements of ES 3139.
2. The chemical composition and forms of products for wrought aluminum and aluminum alloys shall comply with ES ISO 209.
3. The sheets, strips and plates of wrought aluminum and aluminum alloy shall comply with ES ISO 6361.
4. Tubes and profiles of wrought aluminum and aluminum alloy shall comply with ES ISO 6362.

2.03 FABRICATION

A. General: Fabricate metal windows in accordance with approved shop drawings. Form sections in one piece, straight, true and smooth. Prior to fabrication, all hot rolled steel sections shall be cleaned by shot blasting. Provide drips and weep holes in accordance with manufacturer’s standard practice.
1. Attachment of manufacturer's metal nameplates shall not be permitted on any window surface.

B. Frame: Members shall be modified channel shapes. Corners of frame and ventilators shall be mitered or coped then solidly welded. Head and jamb members shall have integral screen-stops. Integrally roll continuous flange at jambs and heads to form a caulking stop between facing and backing masonry. Exposed and contact surfaces shall be finished smooth, flush, with adjacent surfaces.

C. Sills: Sills shall have stepped rebates to receive lower sash bottom rail, which shall be kept clear of sill wash. Sills shall not be perforated at any point in their full length. Weld strap anchors to underside of sill, or screw to tapped lugs welded thereto.

D. Sash: Rails shall be tubular. Stiles may be tubular or modified channel shape. Stiles and rails shall be formed in one piece from single strips. Make sash rebates minimum 15 mm (19/32 inch). Make interior horizontal top surfaces of both meeting rails flat and in same plane. Meeting rails shall have tight contact with wedge blocks at jambs when sash is closed. Cope, end-lap and weld all corners of sash.

E. Glazing: Design windows for interior glazing. Provide continuous removable snap-in metal glazing beads to suit specified glazing.

F. Mullions: Provide manufacturer's standard or a structural shape mullion at multiple unit openings. Make mullions full height of opening and embed them to minimum depth of 125 mm (5 inches) into sill, or securely anchor at head and sill with zinc-coated sheet steel extensions, standard bent-clips or offset shapes of 1.7 mm (14 gauge) zinc-coated steel.

G. If windows and interior metal window trim are installed as complete units, mullions may be anchored at head by means of 5 mm (3/16 inch) steel plate clip bolted to mullion and welded to lintel, and supported at sill with 2.3 mm (12 gauge) zinc-coated steel bent clips welded to mullion.

H. Closures: Miter or cope closure corners and fit with tightly closed joints. Secure closures to window frames with non-corrosive machine screws or expansion rivets, and to masonry with fasteners specified.

I. Reinforcing: Reinforce window frames for attachment of screens, screen hardware or travel-limit lug. Full or limited length reinforcing plates shall be welded to back of frames, and shall be 3 mm (1/8 inch) thick and of sufficient width to securely hold fasteners.

J. Welding: Dress all exposed welds and joints, flush and smooth.

K. Fasteners for Anchoring: Where type, size or spacing of fasteners for securing windows and accessories to building construction is not shown or specified, use expansion or toggle bolts or screws, recommended by manufacturer for construction material adjacent to window units. Bolts or screws: Minimum 6 mm (1/4 inch) diameter and spaced not over 600 mm (24 inches) on centers.
   1. Expansion shield and bolt assemblies shall provide holding power beyond tensile and shearing strength of bolt.
   2. Power actuated drive pins may be used for securing anchors to concrete if recommended by manufacturer.

L. Weather-stripping: Install weather-strips, as standard with manufacturer, at head, jambs, sill, and meeting rails of sash and of impost. Weather-strip shall be applied to both integral weather-strip grooves of aluminum weather-strip adapter. Secure weather-strip adapter to frame surface.

M. Tolerance for Window Size (height and width) Dimensions: Comply with applicable Referenced Standards.

N. Hardware: Unless otherwise shown or specified, comply with applicable Referenced Standards for use with the particular type of window, location, and screen condition.

2.04 SHOP FINISHES

A. Paint Finishes:
   1. Prime Coat: After fabrication, steel windows, fins, mullions, cover plates and associated parts shall be cleaned, properly treated, prime painted with manufacturer's standard prime paint.
   2. Factory Finish: After fabrication, for type of factory finish selected, steel windows and associated components shall be cleaned, and shall be given appropriate treatments in accordance with applicable Referenced Standards:

PART 3 EXECUTION

3.01 EXAMINATION

A. Window openings shall conform with details, dimensions and tolerances shown on window manufacturer's approved shop drawings.

B. Conditions which may adversely affect window installation shall be brought to Contractors attention, for repair, prior to commencement of window installation. Do not proceed with window installation until unsatisfactory conditions have been corrected.

C. Wash-down of adjacent masonry shall be completed prior to erection of windows to prevent damage to window finish by cleaning materials.

3.02 INSTALLATION

A. General: Windows specified under this section shall be installed by experienced personnel as approved by window manufacturer.

B. Install windows in strict accordance with approved shop drawings.
   1. Set units plumb, level and true to line, without warp or rack of frames.
   2. Anchor units securely to surrounding construction with a minimum of three adjustable asphalt coated or galvanized steel anchors with approved fasteners in accordance with manufacturer's recommendations.
   3. Exterior joints between sash, trim and mullions shall be properly sealed watertight with an approved sealant as specified in Section 07 92 00, JOINT SEALANTS, and neatly pointed. Finished work shall have weather-tight joints.

C. Protect window equipment during construction.

D. Upon complete installation of all windows and accessories, and before acceptance of work, adjust all movable sash and operating mechanism for free and easy operation, and defects of any nature.

E. Furnish certificate, signed by both contractor and window manufacturer, stating that installation of windows was done by installers approved by manufacturer of windows.

F. Install one window cleaning anchor at each side edge of each window unit.

3.03 ADJUSTING AND CLEANING

A. Adjust ventilators and hardware for smooth operation and weather-tight closure. Lubricate hardware and other moving parts.

B. Clean window units promptly after completion of installation.

3.04 PROTECTION

A. Protect windows from damage until final inspection and acceptance.

END OF SECTION

SECTION 087100

FINISH HARDWARE

PART 1 GENERAL

1.01 REFERENCES

A. ES 2947: Building Hardware Cylinder for Locks – Requirements and Test Methods

B. ES 2311: Building Hardware – Controlled Door Closing Devices – Requirements and Test Methods.

C. ES 2966: Building Hardware – Door and Window Bolts – Requirements and Test Methods

D. ES 2969: Building Hardware – Single Axis Hinges – Requirements and Test Methods.

E. ES 2954: Building Hardware – Hardware for Sliding Doors and Folding Doors – Requirements and Test Methods

F. ES 1524: Specification for Locks and Latches for Doors in Buildings.

G. ES 2983: Building Hardware – Locks and latches – Mechanically Operated Locks, Latches, and Locking Plates – Requirements and Test Methods.

H. ES 2984: Building Hardware – Gasket and Weather-stripping for Doors, Windows, Shutters, and Curtain Walling – Part 1: Performance Requirements and Classification.

I. ES 2943: Building Hardware – Electrically Powered Hold-open Devices for Swing Doors - Requirements and Test Methods.

J. ES 2959: Building Hardware – Corrosion Resistance - Requirements and Test Methods.

K. ES 2926: Building Hardware – Emergency Exit Devices Operated by a Lever Handle or Push Pad - Requirements and Test Methods.

L. ES 2942: Building Hardware – Panic Exit Devices Operated by a Horizontal Bar - Requirements and Test Methods.

M. ES 2944: Building Hardware – Door Coordinator Devices - Requirements and Test Methods.

N. ES 3004: Building Hardware – Lever Handle and Knob Furniture - Requirements and Test Methods.

O. BS 6000-1-3-6: Glossary of Building and Civil Engineering Terms. Part 1 – General and Miscellaneous – Section 1.3: Parts of Construction Works – Subsections 1.3.6: Jointing Products, Builders' Hardware and Accessories.

1.02 DEFINITIONS

A. The terms in this section shall comply with the terms and definitions of BS 6000-1-3-6 and the following:
   1. Builders' hardware: Fasteners, fastenings and fittings.
   2. Fastener: Jointing component that is used to operate a door, window, shutter, gate and drawer.
      a. Lock: Fastener controlled by a key or similar device that secures a movable component within a frame or opening.
      b. Latch: Fastener, self-engaging and usually operable from both sides of a component that holds it in a closed position and is released by hand.
      c. Key: Device that is removable and portable and is used to operate a fastener.

   3. Fastening: Jointing component that is used for connecting one part to another.
      a. Hinge: Fastening between two adjacent parts that permits rotary movement of one part relative to the other about a single axis.
      b. Screw: Fastening, with a spiral or helical threaded shank and indented head that is inserted into position by turning.
      c. Hanger: Metal section used to suspend one component from another.

   4. Fitting: Small component, usually of metal, other than a fastener that is fixed to a primary component for a specific purpose.
      a. Handle: Fitting for opening and closing doors windows, gates and drawers by hand.
      b. Knob: Handle of spherical, ovoid or similar form.
      c. Door stop: Fitting fixed to a floor or wall to limit the opening of a door or leaf.

   5. Door plate: Plate to protect part of the surface of a door leaf.
      a. Kicking plate: Door plate fixed across the bottom of a door leaf.

1.03 SUBMITTALS

A. Finish hardware submittals:
   1. Finish Hardware Schedule: Submit Hardware Schedule, if required by the Engineer, which includes complete hardware sets for each door and frame shown on Door Schedule.

   2. Product Data: Furnish Manufacture's specification, catalogues and other data required to demonstrate compliance of hardware and components to the standards set in the schedule for approval prior to placement order. In addition to this, the schedule to be submitted for approval shall incorporate the following:
      a. Each hardware item shall be identified by manufacturer, manufacturer's catalogue number, the location of the item in the works and the number of keys (if any).
      b. Manufacturers' catalogue to demonstrate methods of fixing.
      c. Details, templates, and physical samples to demonstrate that they neatly interface with the work on which they are to be installed.

   3. Submit samples as requested.
      a. If samples are required to be submitted such samples shall be submitted for inspection and or approval within the time limit set at the time of request of the

samples. Such samples, when submitted, shall indicate that, they interfaces with the joinery or metalwork item they are to be installed on.

B. Closeout submittals:
   1. Operation and Maintenance Manuals: Furnish the necessary hard copies with the project name and number displayed on the front cover and spine. Include:
      a. List of Manufacturers.
      b. Approved Finish Hardware Schedule.
      c. Approved Manufacturers' Product Data Sheets.
      d. Manufacturer's operation, installation, maintenance, and repair instructions for each type of hardware furnished.
      e. Parts List for each type of finish hardware furnished.
      f. Manufacturers' dated written warranty for each type of finish hardware furnished.
      g. Certifications: Written certification from Contract that their products are installed according to manufacturers' printed installation instructions, are operating properly.
      h. Special Tools: List of special tools, if any, required to install hardware, and their purpose.

1.04 QUALITY ASSURANCE

A. Installers:
   1. Only workmen who are thoroughly trained and experienced in the installation of hardware and fixing of joinery and metalwork on which the hardware is to be fixed shall be employed for hardware installation.

B. On Site Pre-installation Conference: Before finish hardware installation begins, the Engineer's Representative will call a conference at the site to review Finish Hardware Specifications, approved Finish Hardware Submittals, and to discuss requirements for the Work including:
   1. Hardware delivery and storage.
   2. Hardware labeling by door number.
   3. Hardware locations.
   4. Potential location conflicts.
   5. Hardware installation sequence and responsibility.
   6. Required accessories and fasteners.
   7. Continuous hinge installation.
   8. Surface overhead stops and closer template and adjustments.
   9. Special tools and maintenance items.
   10. Hardware Closeout requirements.
   11. Hardware Warranties.

C. Pre-installation Conference Attendance:
   1. The Contractor, authorized finish hardware installers, and the site project manager shall attend the conference.
   2. The Engineer's Representative conducts the meeting.

D. Uniformity of Hardware and Single Source Responsibility:
   1. For each kind of hardware provide product(s) of a single manufacturer otherwise finish of hardware shall be such that all components exposed to view shall have matching finish even if supplied by different manufacturers.

1.05 DELIVERY AND STORAGE

A. Coordinate delivery to avoid delay.

B. Packing and Marking: Individual units of hardware shall, before delivery to site, be packed separately by complete with fastenings and appurtenances clearly marked on the outside to indicate contents. The marking shall he either by name or number cross referenced to the schedule showing the item of work on which it is to be installed.

C. Clearly label each item for identification and installation location as it corresponds to the approved Finish Hardware Schedule and subsequent information bulletins.

D. Deliver hardware to the jobsite in the manufacturers' original packages complete with fasteners, parts, installation instructions, and templates required for proper installation.

E. Inventory hardware at jobsite to identify shortages or backorders. Resolve delivery shortages and damaged items prior to installing hardware.

F. Precaution shall be taken to protect hardware in transit, at the site and during installation. All require or replacements as are necessary, when instructed, shall be made to approval at no additional cost to the Employer.

G. Store finish hardware where directed by Engineer's Representative. Provide locked, dry storage for finish hardware.

1.06 WARRANTY

A. Manufacturer's Warranty: Ten year minimum warranty for door closers, unless specified.

B. Manufacturer's Warranty: Three year minimum for locksets, unless specified.

PART 2 PRODUCTS

2.01 ACCESSORIES

A. Provide brackets, plates, arms, spacers, and special templates to mount door closers in combination with overhead stops and coordinators, on narrow top rails and for special ceiling and jamb conditions.

2.02 FASTENINGS

A. Screws, bolts and other fasteners of suitable size and type to anchor the hardware for long life shall be provided. Fastenings, where necessary, shall be expansion shields, toggle bolts, sex bolts or other approved anchors, recommended by the manufacturer and harmonizing with the hardware as to material and surface finish.

2.03 MATERIALS AND FINISHES

A. General: Unless specified in the Contract Documents, materials and finishes shall comply with the requirements stated in the applicable Referenced standards.

2. Finished surfaces of one material whether extruded, rolled, cast or stamped, shall match exactly in color and texture and all finishes visible on a door face shall be visually identical, unless otherwise specified.
3. All concealed components including lock bodies shall be protected by the manufacturer's standard finish which shall, where applicable, comply with the applicable Referenced standards.
4. Iron or steel surfaces shall be protected by galvanizing, zinc or cadmium plating or other approved corrosion resistance methods.
5. Suitable, matching, metric, positive drive fixings of correct types & lengths shall be provided for background constructions, with visible finishes to match the item fixed.

B. Hinges:
1. Hinges and pivots shall be of the appropriate class for the door size, weight and duty, with heavy-duty, maintenance free, concealed bearings.
2. Hinges shall be stainless steel, all finished to match other hardware on the door face, including plating to match brass, bronze or other finishes, where required.
3. Hinges shall be countersunk drilled, fixed with matching screws & of appropriate type.
4. Comply with the requirements of ES 2969 for single axis hinges.

C. Locks, Latches and Bolts:
1. Comply with the requirements of ES 2983 for mechanically operated locks, latches, and locking plates.
2. Comply with ES 2966 for bolts used for doors and windows.
3. Comply with the requirements of ES 2947 for cylinder for locks.

D. Controlled door closing devices:
1. Comply with the requirements of ES 2311 for manually operated door closing devises for swinging doors.
2. Provide all-weather fluid to eliminate seasonal adjustment of closer speed.
3. A door closer shall be supplied with clear, detailed instructions for its installation, regulation and maintenance, which shall include any limitations of opening angle.
4. Comply with the requirements of ES 2944 for door coordinator devices for double leaf swinging doors fitted with door closers.

E. Lever handle and knob furniture:
1. Comply with the requirements of ES 3004.

F. Hardware for Sliding Doors and Folding Doors
1. The principal components for sliding doors and folding doors of the bi-fold type and multi-panel folding doors excluding doors and panels shall comply with the requirements of ES 2954.

G. Emergency exit devices:
1. Comply with the requirements of ES 2926 for emergency exit devices operated by a lever handle or push pad.

2.04 KEY SYSTEM

A. The works shall after completion be inspected and verified for the correctness of the master or other key system in accordance with the Schedule. The keys, with the number

for each, indicated by the manufacturer, shall be issued to the Employer after such verification.

2.05 GASKET AND WEATHER-STRIPPING

A. Comply with the requirements of ES 2984.

2.06 CORROSION RESISTANCE

A. The corrosion Resistance of hardware for both coated and uncoated surfaces shall comply with the requirements of ES 2959.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine doors and frames and related items for conditions such as, but not limited to, incorrect handing, hardware preparation, misaligned lock and strike preparations, that would prevent proper application of finish hardware. Do not proceed until defects are corrected.

B. Report conditions or hardware applications that are incorrect to the Engineer's Representative.

3.02 INSTALLATION

A. Do not proceed with installation of finish hardware prior to attending referenced pre-installation conference.

B. Installation Sequence:
   1. Use proper installation sequence, i.e., install coordinators, and overhead stops and holders before surface mounted door closers.

C. Install hardware in accordance with manufacturer's printed installation instructions, and adjust for smooth operation, free of sticking, binding or rattling.
   1. Template surface overhead stops and holders for proper operation
   2. Template and adjust closers for proper operation.

D. Use proper tools and methods to prevent scratches, burrs or other defacement.

E. Finish hardware shall be oiled and adjusted where required and left in perfect working order.

F. Screws:
   1. Screws shall be properly inserted to drilled pilot holes with a correctly sized screwdriver. Screws must not be hammered even part of the way in.
   2. Items when fixed where the screw head is burred shall have the screws replaced. Where required, screw or bolt threads shall be plugged to suit the construction to which the item is fixed

G. Gasket Installation:
   1. Install continuous stripping at each opening without unnecessary interruptions.
   2. Where fasteners are required, secure fasteners for stripping and seals so they will not work loose during door operation. Exposed heads of fasteners shall be free of sharp edges.
   3. Coordinate meeting stile gasket with hardware before installation.
   4. Install units plumb and level at the optimum location to maintain a permanent effective seal.

H. After installation, cover and protect hardware to prevent damage during remaining construction. Remove protection upon completion of construction.

3.03 LOCATION

A. Install hardware at the exact position indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Post Installation Review: After hardware is adjusted for proper operation, Engineer's Representative will hold a Post-Installation Review with the Contractor, Hardware Distributor and Hardware Installers.
   1. Physically inspect to verify proper application, installation, adjustment and operation of finish hardware, and in particular that:
      a. Latches engage freely without binding. Filing of strike plates to relieve latch bind is not acceptable.
      b. Closers are adjusted for proper spring power; sweep speed, latching speed; and hydraulic back check.
      c. Locations and proper attachment of installed protective hardware are as specified.
      d. There is no field modification of fasteners.
      e. Damaged fasteners are replaced.

   2. Defective hardware is repaired or replaced.
   3. Hardware is to be left clean and free from disfigurement.

B. Hardware shall be neatly and accurately fitted to joinery and metalwork. The finished hardware shall be inspected for accuracy of installation and optimum working conditions

END OF SECTION

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SECTION 088100

GLASS AND GLAZING

PART 1 GENERAL

1.01 REFERENCES

A. Comply with the following Referenced Standards except:
   1. As shown or specified otherwise in the Contract Documents.
   2. As specifically recommended otherwise by the manufacturers of the glass and glazing materials.

B. ES 1655: Workmanship on Building Sites. Code of Practice for Glazing.

C. ES 3111: Specification for Impact Performance Requirements for Flat Safety Glass and Safety Plastics for Use in Buildings.

D. ES 3222: Glazing and Airborne Sound Insulation-Product Descriptions and Determination of Properties.

E. ES ISO 9050: Determination of Light Transmittance, Solar Direct Transmittance, Total Solar Energy Transmittance, Ultraviolet Transmittance and Related Glazing Factors.

F. ES ISO 3170: Glass in Building – Basic Soda Lime Silicate Glass Products Part 1: Definitions and General Physical and Mechanical Properties.

G. ES ISO 1333: Glass and Glazing. Classification.

1.02 SUBMITTALS

A. Product Data: Manufacturer's specifications and installation instructions for each type of glass and glazing material specified, and spacers and compressible filler rod.

B. Samples:
   1. Glass: 300mm x 300mm pieces for each type of glass specified.
   2. Setting blocks, full size.
   3. Sealing materials for each type.
   4. Color Samples for Glazing Materials: Manufacturer's standard colors for selection and approval by the Architect/Engineer for the following.
      a. Gasket.
      b. Tinted Glass.

   5. Pattern Samples:
      a. Manufacturer's standard patterns.

C. Quality Control Submittals:
   1. Test Reports: Certified test data to sufficiently substantiate glass or glass assembly compliance with requirements specified.
   2. Certificates:
      a. Affidavit required under Quality Assurance Article.

b. Wired Glass: Affidavit required under Quality Assurance Article.

1.03 QUALITY ASSURANCE

A. Compatibility of Materials: All components of the glazing system shall be manufactured or recommended by one manufacturer to assure the compatibility of materials.

B. Workmanship: Comply with the requirements of ES 1655.

C. Certification:
1. Affidavit by the material supplier, certifying type and quality of glass furnished.

1.04 DELIVERY, STORAGE, AND HANDLING

A. General: The delivery, storage and handling of glazing materials and components shall comply with the requirements stated in ES 1655 and the following:
1. Protect glass from edge and other damages during delivery, handling, storage, and installation.

B. Delivery:
1. The delivery tickets and certificates shall correspond to the materials and components delivered and shall comply with the specification of the Contract.
2. Marks and labels and conditions of materials and components shall be checked.
3. Schedule delivery to coincide with glazing schedules so minimum handling of crates is required. Do not open crates except as required for inspection for shipping damage.

C. Handling:
1. All units and sheets shall be handled carefully to avoid breaking or chipping the glazing materials and injury to people to site.
2. Serviceable equipment shall be used.
3. Any warning labels affixed upon receipt of the consignment shall be read carefully and shall be taken action accordingly.

D. Storage:
1. The storing area shall be prepared level and adequately firm to support the weight of units and sheets.
2. The location of the store shall be selected to protect the units and sheets from accidental damage and not to be a hazard to the site.
3. Shade and shelter shall be provided to protect the units and sheets from the sun and rain. The insulating glass units and plastics glazing sheets shall be kept away from heat sources.
4. Store cases according to printed instructions on case, in areas least subject to traffic or falling objects. Keep storage area clean and dry.
5. Unpack cases following printed instructions on case. Stack individual windows on edge leaned slightly against upright supports with separators between each.

1.05 PROJECT CONDITIONS

A. Environmental Requirements: Comply with glazing materials manufacturer's written recommendations regarding environmental conditions under which glazing materials can be installed.

B. Glazing channel dimensions shown are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate glazing material thicknesses, with reasonable tolerances. Provide correct glass size for each opening, within the tolerances and necessary dimensions required.

PART 2 PRODUCTS

2.01 GLASS

A. Glass shall generally be annealed float, polished flat glass, toughened or tempered plate glass free from bubbles specs and other imperfections and complying with the particular material specifications and classifications hereunder and the stated References above or schedules and drawings. In addition to these requirements, the specific type requirements shown in the following subsections shall be met:

B. Use thickness stated on the Contract Documents: (Technical specification, Drawings, Bill of quantities).

C. Transparent Sheet Glass: Transparent sheet glass shall be clear, light transmitting and capable of distinctly showing objects thorough. Transparent glass shall be ordinary quality (OQ), selected glazing quality (SQ) and special selected quality (SSQ) depending on the quality of work to be achieved and may be colored or tinted as required.

D. Figured Glass: Figured glass shall be identified for quality as in sheet glass but having sufficient imprinting of texture or pattern to obscure vision partially or totally as specified and yet capable of allowing the transmission of light. Figured glass shall be clear or tinted. The pattern or texture of the figuring shall be subject to approval.

E. Opaque Glass: Opaque glass shall meet the requirement of transparent sheet glass for quality but shall have white or other approved color to obscure vision partially or totally as specified but transmitting light through.

F. Wired Glass: Wired glass shall be Georgian or normal hexagonal mesh in transparent, figured or opaque glass as specified. The requirements of transparent, figured or opaque glass shall be met in addition to the standards required for wired glass.

G. Glass Block: Glass block shall be translucent with normal pressed finish on both faces and capable of carrying its own and superimposed weight. The jointing faces shall be shaped or coated to ensure adequate bond between glass and concrete or mortar.

H. Setting blocks: Use setting blocks of appropriate size which are rot-proof, non-absorbent and load bearing, capable of maintaining the requisite edge clearance without presenting local area of stress to the glass through being incompressible or un-resilient.
   1. Use the block material made of sealed hardwood of suitable density, hammered lead or extruded PVC, or plasticized PVC (with a softness number of 35 to 45).
      a. Size: in accordance with the requirements of ES 1655.

I. Polished Plate Glass for Mirror: Unless otherwise specified in the Contract Documents, mirrors shall be produced from minimum 6mm thick polished plate glass silvered on one side with the quality of silvering depending on the standard of finish required. Mirror

work shall include mirrors, shelves and cabinets. Where cabinets and shelves are to be built in other materials, the requirements specified in the specifications for such materials shall be complied with.

2.02 GLAZING MATERIALS

A. General: Unless otherwise specified, the materials to be used for glazing shall be identified from the table stated in ES 1655 and the following:
   1. Bedding and sealing materials:
      a. Metal casement putty: Use putty on most non-absorbent surfaces, such as steel (non-stainless) and sealed wood and sealed concrete (but not with PVC).
      b. Linseed oil putty: Use the putty only on primed (but not with micro-porous stain finishes).

B. Glazing Accessories:
   1. Glazing clips, shins, angles, beads, setting blocks and spacer strips supplied with the items to be glazed shall be of appropriate type in accordance with the Referenced Standards and matching the color and quality of the other accessories. Such accessories shall have finishes that do not corrode or stain.

2.03 CLASSIFICATION

A. Complying with ES ISO 1333 and in accordance with the following types:
   1. "Clear float or polished plate glass" identified for quality (OQ, SQ, SSQ, and Tempered) and tint.
   2. "Figured float or polished plate glass" identified for quality (OQ, SQ, SSQ, and Tempered), tint and texture or pattern.
   3. "Opaque float or polished plate glass" identified for quality (OQ, SQ, SSQ, Tempered) and color
   4. "Wired Glass" identified for quality (OQ, SQ, SSQ, and Tempered) and stating whether clear, figured or opaque and tint.
   5. "Glass Block" specifying color and thickness
   6. "Glass Mirror" specifying sizes and thickness, whether in shelf or cabinet and degree of silvering. Drawings or schedules to show cabinets shall he submitted with schedule of glazing.
   7. "Security and Other special purpose glazing" - The technical specifications, drawings and schedules required to enable procure and install glass for this purpose shall he included in this specification as required.

PART 3 EXECUTION

3.01 PREPARATION

A. Glass shall be cut to size and edge rounded at shop or work site to accurate dimension leaving equal play on all sides.

B. All items in which glazing is to be fixed shall he free from dirt, grease, oil or other elements impairing the fixing and likely to stain the glazing and sealant.

C. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

D. Inspect each piece of glass immediately before installation, and eliminate pieces which have observable damage or face imperfections.

E. Apply primer or sealer to joint surfaces wherever recommended by sealant manufacturer.

3.02 INSTALLATION

A. Glazing shall be fixed with visible lines and waves running in the horizontal direction.

B. Glazing shall be set in position with equal edge clearance on all sides. The play around all edges ether puttied or not shall not exceed 2mm unless indicated.

C. Glazing shall be fixed or stopped with the beads furnished with the item to be glazed, whether putty or gaskets are used.

D. Moving items shall be securely closed or locked in position until glazing compound has thoroughly set.

E. Special precaution shall be taken to ensure that sealants and gaskets used in external glazing are and water tight.

F. Excess compounds, smears, labels and paints spots shall be removed and both faces of the glass cleaned to ensure that the surface is free of any scratches or defacing marks.

G. Each installation shall withstand normal temperature changes, wind loading, and impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glazing materials and other defects in the Work.

H. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.

I. Install glazing materials in accordance with the manufacturer's printed instructions.

3.03 GLAZING TECHNIQUES

A. General: The glazing method shall be selected depending on size of glazing sheet, exposure, degree of movement, type of frame material and profile, accessibility, etc., and shall follow the requirements stated in ES 1655.

B. Glazing blocks: Incorporate setting and location blocks and distance pieces to provide support in relation to size of sheet or unit, technique of glazing and condition of use as described in ES 1655.

1. Always use setting blocks of proper size, except when glazing single panes of glass less than 0.2 m^2 with putty or plastic glazing compound, or with certain types of gasket, or with plastics glazing sheet materials.

C. Voids and Filler Rods: Prevent exudation of sealant or compound by forming voids or installing filler rods in the channel at the heel of jambs and head (do not leave voids in the sill channels) except as otherwise indicated, depending on light sizes, thickness and type of glass, and complying with manufacturer's recommendations.

D. Do not cut, seam, nip, or abrade glass which is tempered, heat strengthened, or coated.

E. Force glazing materials into channel to eliminate voids and to ensure complete "wetting" or bond of glazing material to glass and channel surfaces.

F. Tool exposed surfaces of glazing sealants and compounds to provide a substantial "wash" away from the glass. Install pressurized tapes and gaskets to protrude slightly out of the channel, so as to eliminate dirt and moisture pockets.

G. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead.

H. Gasket Glazing: Miter cut and bond ends together at corners where gaskets are used for channel glazing, so that gaskets will not pull away from corners and result in voids or leaks in the glazing system.

I. Structural Gasket Glazing: Cut zipper strips slightly long, to ensure tight closure. Lubricate zipper strip and use special tool to install zipper. Do not lubricate glazing channel or anchorage rabbet. Comply with manufacturer's instructions, including the possible use of sealants and weep holes.

3.04 CURE, PROTECTION AND CLEANING

A. Cure glazing materials in accordance with manufacturer's printed instructions and recommendations, to obtain high early bond strength, internal cohesive strength, and surface durability.

B. Mark glazed openings immediately upon installation of glass by attaching crossed streamers to framing. Do not apply markers of any type to surfaces of glass.

C. Replace glass included in the work which is broken, or otherwise damaged, from the time Work is started at the site until the date of physical completion.

D. Maintain glass in a reasonably clean condition until date of physical completion.
   1. Clean and trim excess glazing material from the glass and stops or frames promptly after installation.
   2. Do not scratch the finished faces with tools or abrasive materials.

E. When directed, or just before the project is turned over to the Procuring Entity, remove dirt and other foreign material and wash and polish glass included in the work on both sides.

END OF SECTION

DIVISION 09 – FINISHES

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SECTION 092300

PLASTERING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Mortar and Masonry Grout: Section 040513.

1.02 REFERENCES

Except as shown or specified otherwise, the Work of this Section shall conform to the requirements of the following Referenced Standards.

A. ES 1658: Workmanship on Building Sites, Code of Practice for Plastering and Rendering.

B. ES 2142: Building Lime-Conformity Evaluation.

C. ES 2119: Code of Practice for External Renderings.

D. ES 1487: Code of Practice for Internal Plastering.

E. ES 2284: Aggregates for Mortar.

F. BS 1369: Metal lathing for Plastering.

G. BS 1199: Sand for External Rendering and Internal Plastering with Lime and Portland Cement.

H. BS 1198: Sand for Internal Plastering with Gypsum Plasters.

I. BS 1230: Gypsum Plasterboard.

J. BS 6100-1-3-7: Glossary of Building and Civil Engineering Terms. Part 1. General and Miscellaneous. Section 1.3. Parts of Construction Works: Subsection 1.3.7 Finishes.

K. BS 6100-6-1: Glossary of Building and Civil Engineering Terms. Part 6. Concrete and Plaster. Section 6.1. Binders.

1.03 DEFINITIONS

A. Unless specified otherwise, the terms in this section shall conform to the terms and definition stated in BS 6100-1-3-7, BS 6100-6-1including the following:
   1. Plaster: Mixture based on a binder that, after the addition of water, is applied while plastic and that hardens after application, generally used to obtain a surface finish.
   2. Gypsum: Naturally occurring or chemically produced Calcium Sulphate Dehydrate from which binders are produced by varying degrees of dehydration.
   3. Lime: Quicklime, hydrated lime, lime putty or slaked lime.
   4. Coat: Continuous layer of coating material that results from a single application.
   5. Coating: Process that leads to the production of coat.

6. Coating material: Material used to cover a surface for protective, decorative or other purposes.
7. Substrate: Surface to which a coating material is applied.
8. Priming coat: Initial coat applied directly to the substrate.
9. Finishing coat: Final coat of a coating system
10. Undercoat: Coat between a priming coat and a finishing coat.

1.04 DESCRIPTION OF PLASTER SYSTEMS

A. Cement mortar: consisting of cement mortar priming coat, cement mortar undercoat, finishing coat cement mortar, render coat, and float finish.

B. Compo mortar: consisting of compo mortar priming coat, compo mortar undercoat, and finishing coat lime plaster.

C. Gypsum plaster: consisting of gypsum plaster priming coat, gypsum plaster undercoat, and finishing coat gypsum plaster.

D. Pointing: Recessed pointing and flush pointing.

1.05 SUBMITTALS

A. Product Data: Manufacturer's name and brand, material type, and specifications:
   1. Cement.
   2. Lime.

B. Quality Control Submittals:
   1. Sand and aggregates: Name and location of source, and test certificate.

1.06 QUALITY ASSURANCE

A. Plasterers shall be skilled workmen who are thoroughly trained and experienced in the necessary crafts. In addition to these requirements assign at least one person who is thoroughly familiar with the specified requirements and capable of guiding the trades' men in the section of materials and execution of the works of this section.

B. Do not use asbestos bearing materials and do not add asbestos to plaster mixes.

C. Allowable Tolerances: Maximum deviation from true plane shall comply with the requirements of ES 1658.

D. Example of Work: Unless specified otherwise, prepare a sample panel for approval before preceding the plastering work.
   1. Construct a 1 m. x 1.5 m. sample panel for each type of plaster, showing color, texture, and workmanship.
   2. Do not proceed with plaster application until sample panel has been approved by the Engineer's Representative.
   3. Maintain sample panel on site for comparison purposes until work of this Section has been finished and approved.

E. Ready-mixed plaster mixes are subject to the approval of the Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage and handling of materials and components shall comply with the requirements stated in ES 1658 and the followings.
   1. Deliver manufactured materials in original sealed containers, with manufacturer's label intact and legible.
   2. The material and components to be delivered to the project site shall be of approved quality, clean and undamaged.
   3. Keep cement, gypsum and lime dry, stored off ground, under cover.
   4. Keep different materials in separate stacks.
   5. Stack bags away from walls, closely together not more than eight bags high.
   6. Stack bags so that consignments can be used in the order of delivery.
   7. The storing of sand & aggregates shall be as specified under Cast-in-Place Concrete Section.
   8. Remove wet, lumpy, and hardened materials from the site.

1.08 PROJECT CONDITIONS

A. Environmental Requirements: Comply with the environmental requirements of applicable Referenced Standards and the following;
   1. Do not use frozen materials in plaster mixes.
   2. Do not apply plaster to surfaces that are frozen or contain frost.
   3. Do not apply plaster when ambient temperature is less than the requirement.
   4. Interior Plastering: Make arrangements thru the Engineer's Representative to have the required temperature maintained for a minimum of 24 hours prior to application, during application, and until plaster has cured.
   5. Exterior Plastering: Provide heated shelters when necessary. Maintain required temperature for a minimum of 24 hours prior to application, during application, and until plaster has cured.
   6. Small on-the-job mix adjustments recommended by the plasterer for working characteristics and drying conditions may be made with the approval of the Engineer's Representative.

B. Protection:
   1. Protect adjacent finishes with suitable, non-staining covers.
   2. Protect plaster from uneven and excessive evaporation and from temperature differentials until it has cured.

PART 2 PRODUCTS

2.01 GYPSUM PLASTER MATERIALS

A. Gypsum plasters for internal plastering shall comply with the requirements of ES 1487.

B. Sand: Shall comply with BS 1198.

2.02 GYPSUM PLASTER BOARD

A. Gypsum plasterboard when used as a background to plastering system should comply with BS 1230.

2.03 COMPO MORTAR AND CEMENT PLASTER

A. Cement shall comply with one of the following:
   1. ES 2169 for low heat Portland cement.
   2. ES 2171 for sulfate - resisting Portland cement.
   3. ES 2179 for pozzolanic pulverized-fuel ash cement.

B. Lime: Shall comply with ES 2142.

C. Sand: Shall comply with BS 1199.

2.04 MISCELLANEOUS MATERIALS

A. Water: Potable, clear, and free of substances harmful to plaster.

B. Bonding agents: Shall comply with the requirements stated in ES 1487.

C. Metal lath for plastering: Shall comply with the requirements of BS 1369.

2.05 CEMENT PLASTER MIX COMPOSITION

A. The mix proportion of cement-sand for priming coat, undercoat and finishing coat shall comply with the requirements stated in ES 1487.

2.06 COMPO MORTAR MIX COMPOSITION

A. The mix proportion of compo mortar for priming coat, undercoat and finishing coat shall comply with the requirements stated in ES 1487.

2.07 GYPSUM PLASTER MIX COMPOSITION

A. Shall comply with the requirements stated in ES 1487.

2.08 RENDER COAT MIX COMPOSITION

A. The mix proportion of cement-lime-sand, cement-ready mixed lime-sand, cement-sand and mortar cement-sand shall comply with the requirements stated in ES 2119.

2.09 FLOATING MIX COMPOSITION

A. 1 part cement to 2 parts of fine sand by volume.

2.10 POINTING MIX COMPOSITION

A. 1 part of cement to 2 parts of fine aggregate by volume.

2.11 AGGREGATES

A. Shall comply with ES 2284.

B. Aggregate for plaster and pointing shall be naturally occurring sand or crushed aggregate. The aggregate shall be hard, clean, free from adhered coatings with no clay content

C. Aggregate shall be free of harmful organic and inorganic material that may affect the setting, strength, durability and appearance of render or undercoat and material in contract with it

D. The clay and fine silt content of aggregate shall not exceed 5% by weight.

2.12 MIXING

A. General:
   1. Mixing process for mortar shall comply with the requirements of the "Section 040513" of this Specification
   2. Accurately proportion materials for each batch with measuring devices of known value.
   3. Size batches for complete use within maximum of one hour after mixing.
   4. Do not use frozen, caked, or lumpy materials. Remove such materials from the site.
   5. When sand is required in mix proportions, use moist loose sand.
   6. Withhold 10% of mixing water until mixing is almost complete. Add remainder as needed to produce necessary consistency.

B. Machine Mixing:
   1. Unless otherwise approved by the Engineer's Representative, mix materials in a power mixer.
   2. Clean mixer of set materials before loading each new batch.
   3. Maintain mixer in continuous operation while adding the components. After all materials are in the machine, continue mixing for at least 2 minutes.

PART 3 EXECUTION

3.01 PREPARATION

A. Generally the preparation of backgrounds that receives plastering and rendering shall comply with the requirements stated in the Referenced Code of Practices and Standards in this Section.

B. Remove dust, loose particles and other foreign matter which would affect bond of plaster.

C. Wet absorptive bases with a fine spray or fog of clean water to produce a uniform moist condition.

D. When interior concrete surfaces are smooth, dense, and not suitable for keying of the plaster coat, prepare surfaces and apply bonding compound in conformance with the manufacturer's instructions.

E. Concrete surface shall be hammered to form key Chases shall be formed before services are installed and made good thereafter prior to plastering.

F. Prior to plastering, joints of stone, brick and concrete blocks shall be raked, to form key. Where making good with plastering is required, the surface shall be cut out to a rectangular shape with the edges forming dovetail key.

G. Cracks, blisters and other defects shall be cut out and made good. Where required, dubbing shall be made with the same material as the under coat application.

3.02 INSTALLING ACCESSORIES

A. Provide all accessories required for a complete finished installation.
   1. Set accessories plumb or level, and true to line. Use shims where necessary. Align joints with concealed splices and tie plates. Attach accessories to substrate as per the requirements stated on the Referenced Standards.
   2. Install continuous corner beads at all external corners of plaster.
   3. Unless otherwise indicated, install continuous casing beads to terminate plaster at head and jambs of doors and windows, at each side of expansion joints, and at internal corner junctions of load bearing and non-load bearing elements.
   4. Unless otherwise indicated, install screeds at control joints and along top of wainscots.

3.03 PLASTER APPLICATION AND CURING

A. General:
   1. Internal plastering: shall comply with ES 1487.
   2. External rendering: shall comply with ES 2119.
   3. Workmanship: shall comply with ES 1658.
   4. Application of metal lath: comply with BS 1369.
   5. Provide plaster thicknesses complying with the Referenced Standards or on the Drawings. On solid base, thickness will be measured from face of base material. On metal lath base, thickness will be measured from the back plane of metal lath.
   6. Apply plaster by hand or machine, unless otherwise indicated.
   7. Over metal lath, apply plaster by hand only.
   8. Provide 3 coat applications consisting of priming coat, undercoat, and finishing coats as required.
   9. Final coats shall form true, sharp lines at angles and against other items. Where plaster abuts flush trim, make a small V-joint in the final coat at the trim.
   10. Stop off plaster application only at junctions of plaster planes, at openings, or control joints.
   11. Except for metal lath, apply base and finishing coats to moist surfaces only.
   12. Ready-Mixed Materials: Follow the manufacturer's application instructions.
   13. In spaces where plastering is indicated on the Drawings, apply plaster on surfaces of reveals, soffits, pilasters, columns, and other related surfaces, except where other finish is shown.
   14. Extend priming coat and undercoat in back of built-in casework unless otherwise indicated. Carry final coat a maximum of 3mm past edges of built-in casework.

B. Priming Coat:
   1. Allow scratch coat to set hard, but not dry, before application of brown coat. Maintain moisture by fogging with clean water as necessary.
   2. The priming coat shall have maximum thickness of 5mm and shall be trowel, spread or machine sprayed, struck off level and left to cure for 24 hours.

C. Undercoat:
   1. Plumb line for the second coat shall be established on wetted priming coat.
   2. The undercoat shall have a maximum thickness of 12mm applied by trowel and left to cure.

3. Straighten and float gypsum plaster to an even plane to allow for finish coat of uniform thickness. Let second coat set hard. Make certain that brown coat is moist when applying final coat.
4. Straighten and float compo mortar and cement plaster to an even plane and cross scratch lightly to form key for finishing coat. Moisture cures for not less than 24 hours by fogging with clean water. Maintain moist curing until finishing coat is applied.

D. Finishing Coat:
1. Finishing coat shall be applied by trowel or machine sprayed, finished level and smooth to a maximum thickness of 3mm and left to cure.

E. Curing of Plaster:
1. The successive coats in turn shall he wetted and the priming coat left to cure for 24 hours, undercoat for 21 days and finishing coat for 25 days before further finish is applied. Where finishing coat is cement plaster, this coat shall be applied within 24 hours of the undercoat.

3.04 POINTING

A. General:
1. Surface to receive pointing shall be thoroughly cleaned and wetted before surface application.
2. Prior to application joints of stone, brick and concrete blocks shall be raked out to a minimum depth of 5mm. Raked out joints shall be flush or recess pointed with stuck weathered horizontal joints and square vertical joints.
3. Pointed surfaces shall be cement dusted or cement paste applied to form a final even and smooth surface, wetted for seven days and left to cure for 28 days.

3.04 CLEAN-UP

A. Clean adjacent surfaces that have been soiled or defaced due to performing the work of this Section. Restore marred or damaged surfaces.

END OF SECTION

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Ministry of Construction

SECTION 093000

TILING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-In-Place Concrete: Section 033000.

1.02 REFERENCES

A. ES 13006: Ceramic Tiles – Definitions, Classification, Characteristics and Marking.

B. ES 1822: Glass in Building – Special Basic Products 2. Glass Ceramics.

C. ES 1536: Specification for Adhesives for Use with Ceramic Tiles and Mosaics.

D. ES 2139: Adhesives for Tiles – Definitions and Specifications.

E. ES 1659: Workmanship on Building Sites. Code of Practice for Wall and Floor Tiling. Ceramic Tiles, Terrazzo Tiles, and Mosaics.

F. ES 1660: Workmanship on Building Sites. Code of Practice for Wall and Floor Tiling. Natural Stone Tiles.

G. ES 3068: Wall and Floor Tiling – Part 1: Code of Practice for the Design and Installation of Internal Ceramic and Natural Stone Wall Tiling and Mosaics in Normal Conditions.

H. ES 3069: Wall and Floor Tiling – Part 2: Code of Practice for the Design and Installation of External Ceramic Wall Tiling and Mosaics (Including Terra Cotta and Faience Tiles).

I. ES 3070: Wall and Floor Tiling – Part 3: Code of Practice for the Design and Installation of Ceramic Floor Tiles and Mosaics (Formerly Part of CP 202).

J. ES 3071: Wall and Floor Tiling – Part 4: Code of Practice for Tiling and Mosaics in Specific Conditions.

K. ES ISO 10545-(1-16): Ceramic Tiles.

L. ES 2386: Terrazzo Tiles – Part 1: Terrazzo Tiles for Internal Use.

M. ES 2387: Terrazzo Tiles – Part 2: Terrazzo Tiles for External Use.

N. ES 2408: Specification for Precast Terrazzo Units.

O. ES 2410: Specification for Terrazzo Tiles.

P. ES 2409: Specification for Concrete Flooring Tiles and Fittings.

Q. ES 2284: Aggregates for Mortar.

R. ES 2142: Building Lime-Conformity Evaluation.

S. ES 2169: Specification for Low Heat Portland Cement.

T. ES 2171: Specification for Sulfate - Resisting Portland Cement.

U. ES 2179: Specification for Pozzolanic Pulverized-fuel Ash Cement.

V. ES 2174: Specification for Ready-Mixed Building Mortar.

W. ES 1665: Workmanship on Building Sites, Code of Practice for Sealing Joints in Buildings using Sealants.

X. BS 3260: Specification for Semi-Flexible PVC Floor Tiles.

Y. BS 6100-1-3-3: Glossary of Building and Civil Engineering Terms: Floors and Ceilings.

1.03 DEFINITIONS

A. The terms under this section shall comply with the definitions stated in BS 6100-1-3-3 and the following:
   1. Tile: Thin, flat or shaped component used to form a covering.
   2. Mosaic: Surface finish that consists of an arrangement of tesserae.
   3. Tesserae: Cubic, square or irregular unit, usually small and of marble, glass or ceramic, used as a surface finish.
   4. Terrazzo tile: Tile that consists of Portland cement and marble aggregate with a surface that is ground and polish.

1.04 SYSTEM DESCRIPTION

A. This section specifies the installation of wall and floor for ceramic, terrazzo and natural stone tiles, and also specifies the installation of floor for concrete and PVC floor tiles and accessories.

1.05 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for each of the following:
   1. Tile and trim units.
   2. Setting materials.
   3. Grouting materials.
   4. Marble door thresholds.

B. Samples:
   1. Tile and Grout: Each type and color required.
   2. Trim Units: Each type and shape required.
   3. Color Samples:
      a. Tile manufacturer’s standard range of colors and textures for each tile type required.
      b. Grout manufacturer’s standard range of colors for each grout type required.

4. Marble thresholds.
5. Metal edge strips.

C. Shop Drawings:
1. Layout of patterns shown on the Drawings or as directed by the Engineer.
2. Edge strip locations showing types and detail cross sections.

D. Quality Control Submittals:
1. Tile Grade Certificates/test reports: Furnish tile manufacturer's product quality assurance certificate and/or test reports bearing the manufacturer's certification for each shipment, type and composition of tiles.
2. Installers' Qualification Data:
   a. Name of each person who will be performing the work and their telephone number.
   b. Names and addresses of 3 similar projects that each person has worked on during the past 5 years.

E. Contract Closeout Submittals:
1. Maintenance Data: Tile and grout manufacturer's recommended cleaning and stain removal methods and materials.

1.06 QUALITY ASSURANCE

A. Manufacturer: Unless specified otherwise or received instruction from the Engineer, perform the followings;
1. 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.
2. Obtain ingredients of a uniform quality for each mortar, waterproof membrane, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

B. Certifications:
1. Tile manufacturer's product quality assurance certification for each shipment of tiles.

C. Installers' Qualifications: The persons installing the work of this Section and their Supervisor shall be personally experienced in tiles installation and shall have been regularly employed by a Company installing tiles for a minimum of 5 years.

D. Pre-installation Conference: Before the work of this Section is scheduled to begin, a conference will be called by the Engineer's Representative at the site for the purpose of reviewing the Drawing and the Specifications and discussing requirements for the Work. The conference shall be attended by the Contractor, the tiles installers, and if needed the tiles distributor.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.

B. Materials from containers which have been distorted, damaged or opened prior to installation will be rejected.

C. Store materials in weather-tight and dry storage facility.

D. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

1.08 PROJECT CONDITIONS

A. Environmental Requirements: Do not install tile until construction in spaces is completed. Set and grout tile when ambient temperature and humidity conditions are being maintained to the requirements of applicable Referenced Standards.

B. All work to meet material manufacturer's recommendations.

C. Do not install PVC tile flooring until building is permanently enclosed and wet construction in or near areas to receive tile materials is complete, dry and cured.
   1. Environmental Requirements:
      a. Maintain temperature of materials a minimum of 22 °C (70 °F,) for 48 hours before installation.
      b. Maintain temperature of rooms where work occurs between 21 °C and 27 °C (70 °F and 80 °F), for at least 48 hours, before, during and after installation

1.09 MAINTENANCE

A. Extra Materials: Furnish extra tile, for the amount as specified in the Contract Documents, of each type, composition, pattern, size and color of tile required. Also furnish a proportionate number of trim units. Place extra materials packaged with protective covering in storage at the site where directed.

PART 2 PRODUCTS

2.01 TILES

A. Mosaic:
   1. Comply with ES 3068 for internal wall tile.
   2. Comply with ES 3069 for external wall tile.
   3. Comply with ES 3070 for floor tile.
   4. Comply with ES 1659 for wall and floor tile (as alternative).

B. Glazed ceramic tile:
   1. Comply with ES 1822.

C. Ceramic tile: The classification and characteristics to which ceramic tiles conform shall comply with ES 13006 and the following Standard products characteristics unless specified otherwise in the Contract Documents:
   1. Sampling and basis for acceptance - ES ISO 10545-(1-16).
   2. Dimension and surface quality - ES ISO 10545-2.
   3. Water absorption, apparent porosity, apparent relative density and bulk density - ES ISO 10545-3.

4. Modulus of rupture and breaking strength - ES ISO 10545-4.
5. Impact resistance by measurement of coefficient or restitution - ES ISO 10545-5.
6. Resistance to deep abrasion for unglazed tiles - ES ISO 10545-6.
7. Resistance to deep abrasion for glazed tiles - ES ISO 10545-7.
8. Linear thermal expansion - ES ISO 10545-8.
9. Resistance to thermal shock - ES ISO 10545-9.
10. Moisture expansion - ES ISO 10545-10.
11. Glazing resistance for glazed tiles - ES ISO 10545-11.
12. Frost resistance - ES ISO 10545-12.
13. Chemical resistance - ES ISO 10545-13.
14. Resistance to stains - ES ISO 10545-14.
15. Lead and cadmium given off by glazed tiles - ES ISO 10545-15.
16. Small color difference - ES ISO 10545-16.

D. Terrazzo tile:
1. Comply with ES 2410 for floor and wall tiles.
2. Comply with ES 2408 for precast terrazzo units.
3. Comply with ES 1659 for wall and floor tile (as alternative).

E. Concrete flooring tiles and fittings:
1. Comply with ES 2409.

F. Natural stone tiles: Comply with ES 1660.
1. Granite: Polished, eggshell, honed, fine rubbed, fine axed, dolly pointed, bush hammered, flame textured, air abrasive blasted or tooled.
2. Marble: Travertine, and hard limestone: polished, eggshell, honed or gritted.
3. Slate: Fine rubbed, sawn, riven, or flame textured.
4. Quartzite: Riven.
5. Limestone: Fine rubbed, sawn or tooled.
6. Sandstone: Fine rubbed, sawn, tooled or riven.

G. PVC tile:
1. Shall comply with the requirements of BS 3260.
2. Tiles shall have a minimum thickness of 1.6mm for residential use, 2 mm for commercial use and 3mm for industrial use.

H. Trim Units:
1. Furnish necessary trim shapes of same material, grade, type, and finish as indicated on the Drawing. Furnish trim for head, jambs and sills of openings, external and corners as per the Contract Documents Requirements.

I. Colors: Tile colors shall be as indicated on the Drawings, or if not indicated, as selected by the Engineer from tile manufacturer’s standard range of colors.

2.02 SETTING MATERIALS

A. Portland Cement Mortar:
1. Portland Cement: Shall comply with one of the following as appropriate:
a. ES 2169 for low heat Portland cement.
b. ES 2171 for sulfate - resisting Portland cement.
c. ES 2179 for pozzolanic pulverized-fuel ash cement.

2. Sand: Comply with ES 2284.
3. Hydrated Lime: Comply with ES 2142.
4. Water: Clean and potable.

B. Adhesive:
1. Comply with ES 1536 for ceramic and mosaic tiling.
2. Comply with ES 2139 for natural stone, terrazzo, and concrete flooring tiling.
3. Comply with the requirements of BS 3260 for PVC floor tiling.

C. Primer: As recommended by the mortar/adhesive and tile manufacturer.

D. Mortar mix: The mix, materials, proportion, method and application of mortar shall comply with the following standards.
1. Comply with ES 3068 for internal ceramic and natural stone wall tiling and mosaics in normal conditions.
2. Comply with ES 3069 for external ceramic wall tiling and mosaics (including terra cotta and faience tiles).
3. Comply with ES 3070 for ceramic floor tiling and mosaics.
4. Comply with ES 3070 for ceramic wall and floor tiling and mosaics under specific conditions.
5. Comply with ES 2409 for concrete flooring tiles.
6. Thickness of mortar as specified in the Drawings.

2.03 GROUTING MATERIALS

A. Sand for grouting: Sand for joints with respect to nominal widths shall comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.

B. Proprietary grouts: Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable for;
1. Mix based on cement and sand but modified by the inclusion of various additives.
2. Mixed based on epoxide resin.

C. Cement: sand mortar grouts: Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.

D. Admixtures to grouts:
1. Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.
2. Admixtures to grouts should be used strictly in accordance with manufacturer's instructions, and they should not be added to a proprietary grout unless approved by the manufacturer of the product.

2.04 ADHESIVE FOR PVC TILE

A. Use adhesives, underlayment, primers and polish recommended by the floor resilient material manufacturer.

2.05 WATERPROOFING

A. Waterproofing: As required by the Contract Documents or one of the following, in compliance with the flooring manufacturer's printed recommendations:

1. Elastomeric rubber membrane, neoprene or urethane, one or 2 component liquid formulation.

2.05 MISCELLANEOUS MATERIALS

A. Metal Edge Strips: As required by the Contract Documents or white zinc-alloy terrazzo strips, 0.32 cm wide at top edge with integral provision for anchorage to mortar bed or substrate, unless otherwise indicated.

B. Expansion Joint Materials:
   1. Sealants:
      a. Comply with the requirements stated in ES 1665 and
      b. For materials used for movement joints comply, as an alternative, with the requirements for flexible material selection and properties stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.

   2. Back-up Strip:
      a. Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.

2.06 MARBLE DOOR THRESHOLDS

A. Marble: As required by the Contract Documents.

B. Fabricate thresholds to equal width of door jambs, with true planes, edges straight, and free of chipped or broken arises and corners.
   1. Raised Thresholds: Depth shall be as required to finish 1.3 cm above finished tile floor and have a minimum thickness of 2.5-0.65 cm, unless otherwise shown. Bevel exposed edge arises 0.65 by 0.65 cm.
   2. Flush Thresholds: 2 cm thick, unless otherwise shown.
   3. Finish: Honed finish on exposed faces and edges, unless otherwise shown.

2.07 SOLID PLASTIC THRESHOLDS

A. Solid Plastic Thresholds: Fabricated of a synthetic, homogeneous, monolithic material.
   1. Fabricate to profile shown with eased edges and sanded smooth.
   2. Fabricate thresholds to equal door jamb opening and equal width of door jamb, unless otherwise shown.
   3. Raised Thresholds: Depth and profile shall be as shown on drawings.
   4. The manufacturer’s recommended epoxy type adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Provide concrete substrates comply with flatness tolerances specified in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.

B. Protection: Protect adjacent surfaces before tile-work begins.

C. Cleaning: Clean substrate surfaces in accordance with applicable reference standards and manufacturer's installation instructions.

D. Prior to placing mortar bed, cement slurry bonding coat shall be applied to the subsurface. The mortar setting coat shall be immediately applied to the surface

E. Prior to placing tile, glue shall be spread onto surface using trowel to a depth not exceeding 3mm thick. Comb the adhesive with notched edge of the trowel ensuring that continuous horizontal ribs of adhesive are formed.

3.03 SUBFLOOR PREPARATION FOR PVC FLOOR TILING

A. Shall comply with the requirements of BS 3260.

B. Fill cracks, joints and other irregularities in concrete with leveling compound:
   1. Do not use adhesive for filling or leveling purposes.
   2. Do not use leveling compound to correct imperfections which can be corrected by spot grinding.
   3. Trowel to smooth surface free of trowel marks, pits, dents, protrusions, cracks or joints.

C. Clean floor of oil, paint, dust, and deleterious substances: Leave floor dry and cured free of residue from existing curing or cleaning agents.

D. Preparation of existing installation shall include the removal of existing resilient floor and existing adhesive. Do not use solvents to remove adhesives.

3.04 INSTALLATION

A. Install wall and floor tiles in accordance with the printed installation instructions of the tile and setting material manufacturers and the followings;
   1. ES 3068 for internal ceramic and natural stone wall tiling and mosaics in normal conditions.
   2. ES 3069 for external ceramic wall tiling and mosaics (including terra cotta and faience tiles).
   3. ES 3070 for ceramic floor tiles and mosaics.
   4. ES 3071 for the installation of ceramic wall and floor tiling and mosaics in situations where there are specific functional or environmental requirements and/or conditions that are potentially detrimental to the installation or the background or both.
   5. Comply with the requirements of BS 3260 for PVC tile flooring.
   6. Neutralize and seal substrate as required by the mortar/adhesive manufacturer's instructions.
   7. Mix and apply proprietary setting and grouting materials in compliance with the manufacturer's instructions.

8. Tiles (other than PVC) shall be thoroughly soaked in water for a minimum of 15 minutes before laying/fixing and shall be taken out before use.

B. Joint Pattern: Install tile in grid pattern with joint width in accordance with ES 3068, ES 3069, ES 3070 or ES 3071 as applicable, unless otherwise indicated.

C. Layout tile-work on principal walls, with tile-work field centered in both directions on the floor and lengthwise on walls in each space, so that no tile less than one-half full size will occur, unless otherwise approved to suit the features of the space. Align joints when adjoining tiles are the same size. Maintain uniform joint width.

D. Extend tile-work into recesses and under equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate tile-work neatly at obstructions, edges, and corners without disruption of pattern or joint alignments.

E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

F. PVC tile Layout: Unless specified otherwise, comply with the requirements of BS 3260 and the following.
   1. If layout is not shown on drawings, lay tile symmetrically about center of room or space with joints aligned.
   2. No tile shall be less than 150 mm (6 inches) and of equal width at walls.
   3. Place tile pattern in the same direction; do not alternate tiles.

G. Expansion and Control Joints: Comply with preparation, joint depths and widths, and installation in accordance with ES 3068, ES 3069, ES 3070 or ES 3071 as applicable. Keep expansion and control joints free of setting and grouting materials. Do not saw-cut joints after installing tiles.
   1. Install continuous expansion joint at perimeter of floor/wall juncture.
   2. Install sealants in accordance with manufacturer's printed instructions.

H. Edge Strips: Install metal edge strips at edge of tile meeting other types of flooring, unless otherwise indicated.

I. Edge Strips for PVC floor tiling:
   1. Locate edge strips under center line of doors unless otherwise shown.
   2. Set PVC tile edge strips in adhesive. Anchor metal edge strips with anchors and screws specified.
   3. Where tile edge is exposed, butt edge strip to touch along tile edge.
   4. Where thin set ceramic tile abuts PVC tile, set edge strip against floor tile and against the ceramic tile edge.

J. Grouting: Comply with ES 3068, ES 3069, ES 3070 or ES 3071, as applicable for type of grout and grouting procedure, and manufacturer's installation instructions. Make joints watertight, and without voids, cracks and excess grout. Damp cure in accordance with reference standards and manufacturer's instructions when applicable.

K. Solid Plastic Thresholds: Set the thresholds in a full bed of adhesive as recommended by the Threshold manufacturer.

L. Install waterproofing to comply with waterproofing manufacturer's written instructions to produce a waterproof membrane of uniform thickness bonded securely to substrate.
   1. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

M. Marble Door Thresholds: Set marble thresholds in a full bed of the same type of setting material specified for adjoining tile-work, unless otherwise indicated.
   1. Wood Subfloors: Set marble thresholds in a full bed of epoxy mortar.

3.05 FIELD QUALITY CONTROL

A. Tests: Perform electrical performance testing of the conductive tile floors as required by the Engineer's Representative after installation in accordance applicable Referenced Standards.

3.06 CLEANING AND MAINTENANCE

A. Comply with the requirements stated in ES 3068, ES 3069, ES 3070 or ES 3071 as applicable.

B. PVC tile flooring:
   1. Comply with the requirements of BS 3260.
   2. Clean adhesive marks on exposed surfaces during the application of resilient materials before the adhesive sets. Exposed adhesive is not acceptable.
   3. When protective materials are removed and immediately prior to acceptance, replace any damage tile, re-clean resilient materials, lightly re-apply polish and buff floors.

C. Check the tile-work installation. Remove defective tile and retile. Leave finished installation free of cracked, chipped, broken, un-bonded, and otherwise defective tile-work.

D. On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter. Comply with grouting specifications and with grout manufacturer's printed instructions for materials and method.
   1. Remove latex-Portland cement grout residue from tile as soon as possible.
   2. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.

3.07 PROTECTION

A. Apply heavy Kraft paper, or other approved heavy protective covering, masked in place over tile-work to prevent staining, damage, and wear.

B. Prohibit foot and wheel traffic on newly tiled areas for seven days after completion of installation unless otherwise approved by the Engineer's Representative.

C. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

D. PVC tile flooring protection:
   1. Comply with the requirements of BS 3260.
   2. When construction traffic occurs over tile, cover PVC materials with reinforced Kraft paper properly secured and maintained until removal is directed by Resident Engineer. At entrances and where wheeled vehicles or carts are used, cover tile with plywood, hardboard, or particle board over paper, secured and maintained until removal is directed by Resident Engineer.

END OF SECTION

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SECTION 095000

CEILINGS

PART 1 GENERAL

1.01 REFERENCES

A. ES 3242: Suspended Ceilings – Requirements and Test Methods.

B. ES 1641: Code of Practice for the Selection and application of Particle Board, Oriented Strand Board (OSB), Cement Bonded Particle Board and Wood Fiber Boards for Specific Purposes.

C. BS 8290: Suspended Ceilings.

1.02 SUBMITTALS

A. Submittals Package: Submit the Shop Drawings, Product Data, Samples, and Quality Control Submittals specified below as a package at the same time or on different time schedules as per the agreement with the Engineer.

B. Shop Drawings: Ceiling plans and details that indicate coordinating penetrations and ceiling mounted items, including the following.
   1. Ceiling suspension members.
   2. Method of attaching hangers to supporting building structure.
   3. Ceiling-mounted items including light fixtures; air outlets and inlets; sprinkler heads; and special moldings at walls, columns penetrations, and other junctures with adjoining construction.

C. Product Data: Manufacturer's catalog sheets, specifications, and installation instructions shall be submitted for the Works of acoustical and metal ceiling system for each item specified including:
   1. Each suspension system type specified.
   2. Infill units specified.
   3. Integral access units, etc.

D. Samples:
   1. Samples of each type of work in its component material, and fabricated, assembled, fixed and finished forms shall be produced for approval.
      a. Sample size will be determined by the Engineer.

   2. Suspension System Materials: Exposed suspension system, component members, including moldings, for each color and system type required.
      a. Sample size will be determined by the Engineer.

   3. Material Units: Each type, pattern, and color specified.
      a. Sample size will be determined by the Engineer.

E. Quality Control Submittals:

1. Certification: Manufacturer's written statement, certifying that the suspension system meets or exceeds the specified structural requirements.

1.03 QUALITY ASSURANCE

A. Installers Qualifications: The persons installing the suspended ceiling system and their supervisor shall be personally experienced in suspended ceiling installation and shall have been regularly employed by a company installing systems for a minimum of 2 years.

B. Marking: Complying with the requirements of BS 8290, all suspended ceiling components made from steel and aluminum materials shall be legibly and permanently marked with the registered name of trade mark of the manufacturer of the component.

1.04 PROJECT CONDITIONS

A. Environmental Requirements: Comply with acoustical and metal unit manufacturer's printed temperature and ventilation requirements before, during, and after installation.

B. Space Enclosure: Do not install interior acoustical units until space is enclosed and weatherproof, wet work in spaces is completed, and work above ceilings is complete.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless specified in the Contract Documents the type of material used for ceiling Works shall comply with the requirements of the Referenced Standards.

B. Chipboard Particle board:
1. Chipboard shall be prime quality, in specified thickness complying with requirements of ES 1641.
2. Chipboard shall be straight edge and free from visible defects that might impair strength and appearance.
3. The exposed face of chipboard shall be smooth enough to receive further finish application.

C. Steel: Unless otherwise specified in the Contract Documents, steel used in the manufacture of cold formed sections for use in ceiling grids shall comply with BS 8290.

D. Aluminum: Unless otherwise specified in the Contract Documents, aluminum used in the manufacture of strips and sections for use in ceiling grids shall comply with BS 8290.

E. Infill units: Unless otherwise specified in the Contract Documents, infill units shall comply with the requirements of applicable Referenced Standards.
1. Color and texture as indicated or may be selected from manufacturer's standard colors and textures by the Architect/Engineer.

F. Fasteners: Except where shown or specified, select fasteners of type, size, grade, and class required for secure installation of ceiling system by complying with the requirements of applicable Referenced Standards.

G. Tolerances: The variation of the overall height and width of the cross-section of main runners, cross members and perimeter trims of ceiling materials and length, width, thickness, square-ness and flatness of infill units shall be within the tolerances given in the applicable Referenced Standards.

2.02 FABRICATION

A. Fabricate ceiling members and components as indicated in the Contract Documents or if not indicated comply with the requirements of applicable Referenced Standards.

B. Form ceiling support system from steel shapes, plates, and bars, sizes as indicated, or if not indicated sized to support the specified design loads.
   1. Galvanize ceiling support system after fabrication.

C. Unless otherwise indicated or approved, fabricate ceiling panels for predetermined openings, including opening required by related contracts, and reinforce and close panel edges to maintain panel strength, alignment, profile, and security.

D. Fabricate access panels and removable panels where indicated and required. Coordinate exact locations with related contracts.

2.03 GALVANIZING

A. Unless otherwise specified or noted, items indicated, or specified, to be galvanized shall receive appropriate type of coating by complying with the requirements of applicable Referenced Standards:

2.04 SHOP FINISHING

A. After fabrication, give steel shapes, plates, and bars that will be exposed in the finish system a recommended amount and type of coating applied in accordance with the coating manufacturer's printed instruction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive the work of this Section for defects that will adversely affect the execution and quality of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. General: Unless otherwise specified or noted in the Contract Documents, installation of ceiling Works shall comply with the requirements of applicable Referenced Standards.

B. Ceiling soffits nailed to supports: Chipboards, plywood, hardboard and soft board and metal ceiling panels nailed to timber battens:
   1. Ceiling panels shall be nailed to sawn timber backing. Nails shall be punched and stopped.

2. The sizes, patterns and spacing of battens shall be as indicated on drawings. Where details are not given, the minimum sizes of timber battens shall he 40x50mm and the maximum spacing 600mm centers in both directions. The battens shall be fixed to trusses or rafters in 40x50 mm sawn timber suspenders that may also be used to adjust levels. Where truss spacing is not close enough to keep the ceiling battens level, timber backing nailed or tied to the truss shall he provided as necessary. The pattern of layout, if not given on drawings shall be as directed.
3. Ceiling panel edges shall be finished straight or chamfered as shown on drawings or schedules.
4. Where ceiling panel edges are finished straight, the joints shall he covered with milled timber molded lists not less than 30mm wide. The cover molds shall follow strict and uniform pattern even if they are not to cover joints.
5. The joints of ceiling to wall shall be covered with molded corner lists of width not less than 50mm.
6. The gap to be left between chamfered panels shall he as detailed on drawings or where not shown not less than 10mm.
7. Unless specified, the joint between chamfered panels and walls shall be covered with molded cover fillets of width not less than 50mm.
8. Ceiling panels less than 8min in thickness shall not he chamfered.

C. Suspended Ceiling: Chipboard, plywood, metal, acoustic and other ceiling panels the support frames of which are suspended from supports by wires, chains and steel profiles:
   1. Support metals shall be aluminum, galvanized or coated steel or other approved material to the shapes and dimension shown on drawing or approved.
   2. Ceiling panels shall be accurately sized to the dimension shown on drawings. No bottom support shall be laid out.
   3. Suspended panels with no bottom support shall be laid out and hanged from suspension, ensuring that panels are either with no gap in between, or the gap left in as detailed on drawings.
   4. Panels when joined, shall form true and straight lines. Panels rest on metal supports not than 10mm width of panels shall rest on the support. Where up lifting of panels is likely, ceiling panels shall be securely screwed to supports.

D. Installation of acoustical units:
   1. Install acoustical units in accordance with the manufacturer’s printed instructions, unless otherwise shown or specified.
      a. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
      b. Install acoustical unit level, in uniform plane, and free from twist, warp, and dents.
      c. Scribe and cut acoustical units to fit accurately at borders and at penetrations.
      d. Where tiles are not supported by suspension members, install splines at unsupported joints.
      e. Keep border tiles in compression by inserting spring steel spacers between tiles and moldings. Place one spacer bar at the center of each tile.
      f. Locate integral access units to provide uniformly distributed units equal to 20 percent of the total area of each ceiling.
      g. Install integral access units in locations shown on the drawings.
      h. Hold-down Clips: Install hold-down clips in areas shown on the drawings and in areas required for fire resistance ratings. Space as recommended by panel manufacturer, or as shown or required.

i. Impact Clips: Install impact clip system in accordance with the manufacturer's printed instructions.

3.03 CLEANING AND ADJUSTING

A. Clean exposed surface of acoustical ceilings, including trim, wall moldings, and suspension members. Comply with manufacturer's printed instructions for cleaning and touch-up of minor finish damage.

END OF SECTION

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SECTION 099101

CONSTRUCTION PAINTING

PART 1 GENERAL

1.01 REFERENCES

A. ES 1661: Workmanship on Building Sites. Code of Practice for Decorative Wall Coverings and Painting.

B. ES 853: Paints and Varnishes – Zinc Chromate Primer – Specification.

C. ES 854: Paints and Varnishes – Red Iron Oxide Primer – Specification.

D. ES 855: Paints and Varnishes – Plastic Emulsion Paints – Specification.

E. ES 856: Paints and Varnishes – Enamel Paints – Specification.

F. ES 874: Paints and Varnishes – Inorganic Zinc Silicate Paint – Specification.

G. ES 875: Paints and Varnishes – Organic Zinc Rich Primer – Specification.

H. ES 2168: Pigment for the Coloring of Building Material based on Cement and/or Lime – Specifications and Methods of Test.

I. ES ISO 1248: Iron Oxide Pigments for Paints.

J. ES ISO 1249: Zinc Chromate Pigments – Basic Zinc Potassium Chromate Pigments and Zinc Tetrahydroxy Chromate Pigments.

K. ES ISO 1336: Specification for Black Paints (Tar-Based).

L. ES 857: Paints and Varnishes – Determination of Drying Oil Content of Non-Volatile Vehicle.

M. ES 858: Paints and Varnishes – Determination of Pigment Volume Concentration of Non-Aqueous Solvent Base.

N. ES 859: Paints and Varnishes – Determination of Rosin Acid Content of Paint Vehicle.

O. ES 860: Paints and Varnishes – Determination of Water Content.

P. ES 862: Paints and Varnishes – Determination of Wet and Dry Hiding Power.

Q. ES 870: Paints and Varnishes – Determination of Quantity of Material in a Container.

R. ES 871: Paints and Varnishes – Determination of Color Stability of Paint Films.

S. ES 876: Paints and Varnishes – Determination of Metallic Zinc Content.

T. ES 877: Paints and Varnishes – Determination of Pencil Hardness of Paint Films.

U. ES 878: Paints and Varnishes – Determination of Degree of Setting.

V. ES ISO 11998: Paints and Varnishes – Determination of Wet-Scrub Resistance and Clean Ability of Coating.

W. ES ISO 1524: Paints and Varnishes and Printing Inks – Determination of Fineness of Grind.

X. ES ISO 2808: Paints and Varnishes – Determination of Film Thickness.

Y. ES ISO 2811: Paints and Varnishes – Determination of Density.

Z. ES ISO 2812: Paints and Varnishes – Determination of resistance to liquid.

AA. ES ISO 2813: Paints and Varnishes – Determination of Specular Gloss of Non-Metallic Paint Films at 20, 60 And 85 Degrees.

BB. ES ISO 3248: Paints and Varnishes – Determination of the Effect of Heat.

CC. ES ISO 3668: Paints and Varnishes – Visual Comparison of Color Paints.

DD. ES ISO 6270: Paints and Varnishes – Determination of Resistance to Humidity (Continuous Condensation).

EE. ES ISO 6503: Paints and Varnishes – Determination of Total Lead by Flame Atomic Absorption Spectrometric Method.

FF. ES ISO 8501-1: Preparation of Steel Substrates Before Application of Paint and Related Products – Visual Assessment of Surface Cleanness – Part 1 Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates after Overall Removal of Previous Cotings.

GG. ES ISO 12944-4: Paints and Varnishes – Corrosion Protection of Steel Structures by Protective Paint.

HH. BS 5493: Code of Practice for Protective Coating of Iron and Steel Structures against Corrosion.

1.02 DEFINITIONS

A. The word “paint” in this Section refers to substrate cleaners, fillers, sealers, primers, undercoats, enamels, stains, varnishes and other first, intermediate, last or finish coatings.

B. The word “primer” in this Section refers to substrate cleaners, fillers, sealers, undercoats, and other first or intermediate coats beneath the last or finish coating.

C. The words “finish paint” in this Section refer to the last or final coat and previous coats of the same material or product directly beneath the last or final coat.

D. Finish Paint Systems: Finish paint and primers applied over the same substrate shall be considered a paint system of products manufactured or recommended by the finish coat manufacturer.
   1. Finish paint products shall meet or exceed specified minimum physical properties.

1.03 SUBMITTALS

A. Painting Schedule: Cross-referenced Painting Schedule listing all exterior and interior substrates to be painted and specified finish paint type designation; product name and manufacturer, recommended primers and product numbers, and finish paint color designation for each substrate to be painted.
   1. Designate exterior substrates by building name and number, substrate to be painted and surface location.
   2. Designate interior substrates by building name and number, floor, room name and number, and surface to be painted.

B. Product Data Sheets: Manufacturer's published product data sheets describing the following for each finish paint product to be applied:
   1. Percent solids by weight and volume, solvent, vehicle, weight per gallon, gloss/reflectance angle, recommended wet and dry film thickness, volatile organic compound (VOC) content in kg/gallon, product use limitations and environmental restrictions, substrate surface preparation methods, directions and precautions for mixing and thinning, recommended application methods, square foot area coverage per gallon, storage instructions, and shelf-life expiration date.
   2. Manufacturer's recommended primer for each finish paint product and substrate to be painted.
   3. Manufacturer's complete range of available colors for each finish paint product to be applied.

C. Finish Paint Samples: Two finish paint samples applied over recommended primers for each substrate to be painted.
   1. Samples shall be in the designated color and specified reflectance.
   2. Label each sample with the following information:
      a. Project number and Painting Schedule designation describing substrate location represented by the sample.
      b. Finish paint and primer manufacturer, product names and numbers, finish paint color and reflectance.

   3. Sample Sizes: Determine sample size in consultation with the Engineer's Representative for the following substrates.
      a. Wall, Ceiling, and Floor Substrates,
      b. Finish Wood Substrates,
      c. Concrete and Concrete Masonry Unit Substrates,
      d. Sheet Metals,
      e. Bar and Tubular Metals,

D. Quality Control Submittals:
   1. Test Reports: Furnish certified test results from an independent testing laboratory showing that products submitted comply with the specifications, if requested by the Engineer's Representative.
   2. Certificates: Furnish certificates of compliance required under QUALITY ASSURANCE Article as required.

E. Existing Exterior Paint Film Stripping and Removal Submittals:
   1. Submit proposed materials and methods for removing existing paint films down to a clean and original undamaged substrate.
      a. Depending upon the substrate to be stripped and thickness of paint films to be removed, acceptable methods of removal include hand or mechanical tools, pressure washing with water, heat or steam devices, chemical strippers and other appropriate methods.
      b. More aggressive paint stripping and removal methods will not be accepted when less aggressive methods are equally effective with less damage.
      c. Chemical Strippers: As recommended by a letter of approval from finish paint manufacturer.

1.04 QUALITY ASSURANCE

A. Volatile Organic Compounds (VOCs) Regulatory Requirements: Comply with the Government regulatory requirements.
   1. Certificate of Compliance: List of each paint product to be delivered and installed. List shall include written certification stating that each paint product listed complies with the VOC regulatory requirements in effect at the time of job site delivery and installation.

B. Container Labels: Label each product container with paint manufacturer's name, product name and number, color name and number, thinning and application instructions, date of manufacture and shelf-life expiration, required surface preparation, recommended coverage per gallon, wet and dry film thickness, drying time, and clean up procedures.

C. Field Examples:
   1. Prior to on-site painting, at locations designated by the Engineer's Representative, apply field examples of each paint type to be applied.
   2. Field examples to be applied on actual substrates to be painted and shall duplicate earlier approved paint samples.
      d. Interior field examples to be applied in rooms and spaces to be painted with the same products.
      e. Field Example Minimum Wet and Dry Film Thickness: As indicated on approved product data sheet.
      f. Application: Apply each coat in a smooth uniform wet mil thickness without brush marks, laps, holidays, runs, stains, cloudiness, discolorations, nail holes and other surface imperfections.
         1) Leave a specified exposed width of each previous coat beneath each subsequent coat of finish paint and primer.

      g. Use of Field Examples: Field examples shall serve as a quality control standard for acceptance or rejection of painting Work to be done under this Section.

   3. Field Example Sizes:
      a. Floor, Wall, and Ceiling Examples: 20 square meters.
      b. Door and Frame Examples: One door and frame with 30 cm wide horizontal strips.
      c. Linear Substrate Examples: 5m linear with 30cm long strips.

4. Do not begin applying paints represented by field examples until examples have been reviewed and approved by the Engineer's Representative.
   a. Protect and maintain approved field examples until all painting work represented by the example has been completed and approved.

5. Existing Exterior Paint Stripping and Removal Field Examples: Apply necessary number of examples required to determine least aggressive method for stripping and removing existing paint films without damaging the original substrate.
   a. Example Size: 1.5m by 1.5m at location designated by the Engineer's Representative.

D. Compatibility of Paint Materials: Primers and intermediate paints shall be products manufactured or recommended by the finish paint manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with the requirements stated in ES 1661 and the following:
   1. Delivery: Deliver approved materials to the Site in original, unopened containers and cartons bearing manufacturer's printed labels. Do not deliver products which have exceeded their shelf life, are in open or damaged containers or cartons, or are not properly labeled as specified.
   2. Handling: Unload and handle materials with care to avoid crushing, tearing or damage to packaging, and denting or unsealing of containers.
   3. Storage: Store materials in a clean, dry, well-ventilated store in accordance with manufacturer's published product data sheets and the following.
      a. Store materials providing protection from frozen extremes of temperature change within the range of 5 degrees C and 30 degrees C.
      b. Set aside any material that has been exposed to temperatures outside those stipulated by the manufacturer, until advice has been obtained on its suitability for use.
      c. Store materials so that they can readily be used in order of delivery and issued from store before the expiry of any shelf life period stated by the manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements: Comply with ES 1661 and the following for unsuitable environmental conditions prevailed on the project site.
   1. Ambient Air Temperature, Relative Humidity, Ventilation, and Surface Temperature: Comply with paint manufacturer's published product data sheet or other printed product instructions.
   2. If paint manufacturer does not provide environmental requirements, do not apply painting materials:
      a. To surfaces affected by dump or frost.
      b. When the air or substrate temperature is below, or likely to fall below 5 degree C.
      c. When condensation is likely to occur before the paint is touch is dry.
      d. When rain or snow is likely to affect the paintwork.
      e. When heat is likely to cause faults to develop.
      f. When airborne dust is likely to spoil wet paint.
      g. When the light is insufficient.
      h. To substrates not adequately dried out.

3. Ventilation: Ensure there is adequate ventilation for all painting processes..

1.07 EXTRA MATERIALS

A. Provide extra finish paint materials, from the same production run as paints to be applied, for the quantities as directed by the engineer for each color installed.

PART 2 PRODUCTS

2.01 PAINT PRODUCTS

A. Unless specified or indicated in the Contract Documents, comply with the following requirements stated under this PAINT PRODUCTS part:

B. Plastic emulsion paints shall comply with ES 855.

C. Enamel paints shall comply with ES 856.

D. Black paints (tar-based) shall comply with ES ISO 1336.

E. Zinc chromate primer shall comply with ES 853.

F. Red iron oxide primer shall comply with ES 854.

G. Inorganic zinc silicate paint shall comply with ES 874.

H. Organic zinc rich primer shall comply with ES 875.

I. Color Pigments: Pigment for the coloring of building material based on cement and/or lime shall comply with ES 2168.

J. Iron oxide pigments for paints shall comply with ES ISO 1248.

K. Zinc chromate pigments shall comply with ES ISO 1249.

L. Bedding Compound: Water based pre-mixed gypsum wallboard joint compound.

M. Metal Filler: Polyester resin base auto-body filler.

N. Mineral Spirits: Low odor type recommended by finish paint manufacturer.

O. Paint Stripper: As recommended by finish paint manufacturer.

P. Spackling Compound: Water based pre-mixed plaster and gypsum wallboard finishing compound.

Q. Stain Blocker, Primer-Sealer: As recommended by finish paint manufacturer.

R. Wood Putty: Water based pre-mixed wood filler.
1. Color match putty to wood substrate beneath clear and semi-transparent finishes.

S. Wood Substrate Cleaner, Brightener, Conditioner, and Open-grain Sealer: As recommended by finish paint manufacturer.

2.02 PAINT TYPES

A. Determination of Paint Properties:
   1. Properties of acceptable materials.
      a. Determination of drying oil content of non-volatile vehicle shall comply with ES 857.
      b. Determination of pigment volume concentration of non-aqueous solvent base shall comply with ES 858.
      c. Determination of rosin acid content on paint vehicle shall comply with ES 859.
      d. Determination of water content shall comply with ES 860.
      e. Determination of wet and dry hiding power shall comply with ES 862.
      f. Determination of quantity of material in a container shall comply with ES 870.
      g. Determination of color stability of paint films shall comply with ES 871.
      h. Determination of metallic zinc content shall comply with ES 876.
      i. Determination of pencil hardness of paint films shall comply with ES 877.
      j. Determination of degree of setting shall comply with ES 878.
      k. Determination of wet-scrub resistance and clean ability of coating shall comply with ES ISO 11998.
      l. Determination of fineness of grind shall comply with ES ISO 1524.
      m. Determination of film thickness shall comply with ES ISO 2808.
      n. Determination of density shall comply with ES ISO 2811.
      o. Determination of resistance to liquid shall comply with ES ISO 2812.
      p. Determination of specular gloss of non-metallic paint films at 20, 60 and 85 degrees shall comply with ES ISO 2813.
      q. Determination of the effect of heat shall comply with ES ISO 3248.
      r. Visual comparison of color paints shall comply with ES ISO 3668.
      s. Determination of resistance to humidity shall comply with ES ISO 6270.
      t. Determination of total lead by flame atomic absorption spectrometric method shall comply with ES ISO 6503.

B. Colors: Provide paint colors either shown on Contract Drawings or to be selected by the Engineer from finish paint manufacturers available color selections.
   1. Approved finish paint manufacturers to match designated colors of other manufacturers where colors have been shown on the Contract Documents.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to be prepared, primed, or painted for compliance with Contract Documents, required environmental conditions, manufacturer's product data sheets, product label instructions and other written requirements.
   1. Do not begin any phase of the work without first checking and verifying that surfaces and environmental conditions are acceptable for such work and that any earlier phase deficiencies and discrepancies have been properly corrected.
      a. The commencement of new work shall be interpreted to mean acceptance of surfaces to be affected.

3.02 PREPARATION

A. Protection: Cover and protect both surfaces to be painted and adjacent surfaces not to be painted from existing paint removals, airborne sanding particles, cleaning fluids and paint spills using suitable drop cloths, barriers and other protective devices.
   1. Adjacent exterior surface protections include roofs, walls, landscaping, driveways and walkways. Interior protections include floors, walls, furniture, furnishings and electronic equipment.
   2. Remove and replace removable hardware, lighting fixtures, telephone equipment, and other devices and cover plates over concealed openings in substrates to be painted.
      a. Cover and neatly mask permanently installed hardware, lighting fixtures, cover plates and other devices which cannot be removed and are not scheduled for painting.

   3. Schedule and coordinate surface preparations so as not to interfere with work of other trades or allow airborne sanding dust particle to fall on freshly painted surfaces.
   4. Provide adequate natural or mechanical ventilation to allow surfaces to be prepared and painted in accordance with product manufacturer's instructions and applicable regulations.
   5. Provide and maintain "Wet Paint" signs, temporary barriers and other protective devices necessary to protect prepared and freshly painted surfaces from damages until Work has been accepted.

B. Clean and prepare surfaces to be painted in accordance with specifications, paint manufacturer's approved product data sheets and printed label instructions. In the event of conflicting instructions or directions, the more stringent requirements shall apply.
   1. Cleaners: Use only approved products manufactured or recommended by finish paint manufacturer. Unless otherwise recommended by cleaner manufacturer, thoroughly rinse with clean water to remove surface contaminants and cleaner residue.

C. Surfaces:
   1. Moisture content: Before applying coatings check the moisture content of the substrate will not adversely affect the completed work.
      a. For the application of paints on plastered, rendered, concrete, block and stone surfaces and substrates, ensure that the substrate is completely dry after the completion of their curing time before application of paints.

   2. Existing Exterior Painted Surfaces: Thoroughly clean to remove dirt, soot, grease, mildew, chalkiness and stains using appropriate cleaner complying with the requirements of ES 1661 unless specified otherwise in the Contract Documents.
      a. Apply cleaner using hand-held wand applicator in accordance with product manufacturer's instructions. Thoroughly rinse and remove all residues with clean water.
      b. Remove loose, peeling, cracked and blistered paint by chipping, scraping, and sanding smooth with medium and fine sandpaper.
      c. Completely strip and remove existing paint films where shown on the drawings using approved methods. When approved, a chemical stripper to be applied and rinsed or removed in accordance with product manufacturer's printed instructions.

d. Fill surface holes and depressions with finish paint manufacturer's recommended filler and sand smooth to adjacent undisturbed edges.
e. Touch-up bare spots on previously painted surfaces with finish paint manufacturer's recommended primer.
f. Sand existing semi-gloss and gloss paint surfaces to a uniform smooth dull finish before painting.
g. Fill and sand smooth existing paint surface damages, depressions, ridges and other imperfections that will remain visible after new paints have been applied.

3. Concrete:
   a. Allow appropriate time for poured concrete to dry before painting.
   b. Remove form release agents, laitance, efflorescence, dirt, grease, oils, slurry, chalk deposits, and other surface contaminants as per the requirements of ES 1661.
   c. Ensure that the surface is completely clean and ready for painting.
   d. Chip and grind surface projections smooth to adjacent surfaces.
   e. Open concealed voids and cracks, remove cement slurry by wire-brushing to expose clean aggregate substrate, and chip out surface honeycomb pockets to allow a neat cementitious patch with square corners and a uniform thickness.
   f. Inspect surfaces to be painted for exposed or rusted steel reinforcement and contact Engineer's Representative for a survey of damages to be repaired before substrate can be painted. Do not paint over exposed steel reinforcement without first repairing both deteriorated reinforcement and protective coating.
   g. Use an electronic meter or consult the Engineer to determine moisture content compliance with finish paint manufacturer's recommendations.

4. Concrete Masonry Units:
   a. Allow appropriate time for mortar joints to dry before painting.
   b. Remove severe laitance, efflorescence, dirt, grease, slurry, chalk deposits and other surface contaminants as per the requirements of ES 1661.
   c. Ensure that the surface is completely clean and ready for painting.

5. Existing Structural Steel, Metal Decks and Stairs:
   a. Generally the grade of cleanliness of steel substrates to be painted shall comply with the requirements of ES ISO 8501-1.
   b. For protective paint system, comply with ES ISO 12944-4 for the preparation of steel surface.
   c. Inspect for exposed or rusted steel reinforcement and contact Engineer's representative for an on-site survey of repairs to make before painting. Do not paint over exposed steel reinforcement without first repairing both deteriorated reinforcement and protective concrete covering.

6. Galvanized Metal:
   a. Remove "white rust" using appropriate solvent and, if necessary, wire brushing or sanding.
   b. Generally the grade of cleanliness of steel substrates to be painted shall comply with the requirements of ES ISO 8501-1.
   c. For protective paint system, comply with ES ISO 12944-4 for the preparation of steel surface.

7. Steel Doors and Frames: Fill indentations and cracks with metal filler; sand smooth to match adjacent undamaged surfaces.

8. Aluminum:
    a. Non-corroded Surfaces: Rub with fine steel wool and wipe clean with mineral spirits.
    b. Corroded Surfaces: Sand smooth, rub with fine steel wool and wipe clean with mineral spirits.

9. Wood: Comply with the requirements of ES 1661 and the following:
    a. Remove surface dirt, stains, markings, discolorations and other contaminants using finish paint manufacturer's recommended cleaning methods and solvents.
        1) Wood Decks: Remove previous stains and other surface contaminants to expose clean bare wood before applying finish paints.

    b. Sand raised grain, rough saw-cut edges, planed mill glaze, old paint, and other surface imperfections clean and smooth using medium and fine sandpaper. Sand wood in the direction of grain.
    c. Fill open cracks, knot holes, countersunk fastener holes and other surface indentations with wood filler putty. Sand putty smooth and flush to adjacent unfilled surface.
        1) Color match wood putty to natural wood substrate where surfaces are to be stained or varnished.
        2) Fill and sand smooth open grain woods before sealing, staining or varnishing.

    d. Seal knots, pitch streaks, sap spots, stains and graffiti with finish paint manufacturer's recommended primer/sealer.
    e. Sand wood in the direction of grain.

10. Plaster, Cement Plaster, and Gypsum Wallboard:
    a. Fill cracks, holes, and other indentations smooth to adjacent surfaces using specified bedding, spackling, and finishing compounds.
    b. Plaster: Scrape and sand smooth ridges, spills, nibs, and other surface projections.
    c. Cement Plaster: Coat surfaces to be patched with a bonding agent. Patch cement plaster with an approved mortar patching mix and finish to match adjacent surface and texture.
    d. Gypsum Wallboard: Fill and sand smooth minor bedding and finishing compound defects.
    e. Vacuum and wipe surfaces free of all sanding residue and dust.

11. Glazing Repairs: Cut out and replace dry, loose, and cracked glazing compound or putty.
12. Other Substrates: Comply with the requirements of ES 1661 and see finish paint manufacturer's recommendations.

D. Painting Material Preparations:
    1. Prepare painting materials in accordance with manufacturer's approved product data sheets and printed label instructions and as per the requirements of ES 1661.
        a. Mixing: Do not mix different materials or similar materials made by different manufacturers.
        b. Stir materials before and during application for a consistent mixture of density. Remove container surface paint films before stirring and mixing.

c. Slightly tint first opaque finish coat where primer and finish coats are the same color.
d. Do not thin paints unless allowed and directed to do so in writing within limits stated on approved product data sheets.

3.03 APPLICATION

A. Environmental Conditions: Comply with the requirements of applicable Referenced Standards.
1. Water-based and other Paints: Apply when surface temperatures will maintain the required range throughout the drying period.
2. Apply exterior paints during daylight hours free from rain, snow, fog and mist when ambient air conditions are more than 5 degrees above the surface dew-point temperature and relative humidity less than 85 percent.
a. When exterior painting is allowed or required during non-daylight hours, provide portable outdoor weather recording station with constant printout showing hourly to diurnal air temperature, humidity, and dew-point temperature.

3. Exterior Cold Weather Protection: Provide heated enclosures necessary to maintain specified temperature and relative humidity conditions during paint application and drying periods.

B. General:
1. All paint materials shall he prepared and mixed in strict compliance with the manufacturer's instructions. The mixture shall he stirred as often as required before and during application to produce a mixture of uniform density. Any film forming on the surface of the mixture shall be removed before application. The mixture shall be strained if necessary to remove film and resolve.

C. Sample painted surfaces:
1. At least one sample painted surface shall be prepared for approval as required for the different surfaces to receive paints. All paint work thereafter shall match the approved samples for color, texture and coverage.

D. Install approved paints where specified, or shown on the drawings, and to match approved field examples.
1. Paint Applicators: Brushes, rollers or spray equipment recommended by the paint manufacturer and appropriate for the location and surface area to be painted.
a. Approved minimum wet and dry film thicknesses shall be the same for different application methods and substrates.
b. Successive coats shall be applied only after the drying and approval of preceding coats
c. Surfaces shall be sanded and dusted between coats to remove all visible defects
d. All brush and roller coats shall be applied to the surface in an even film. Cloudiness, runs, spotting, brush marks and the like imperfections shall be removed and the surface left even and uniform in color. Each coat of spray application shall be equivalent to brush applied coat. Spray application shall not be doubled back to apply paint for the purpose of building up film in place of successive coats

E. Paint type coats to be applied: Unless specified otherwise by finish paint manufacturer's product data sheet or in the Contract Documents, the number of coats to be applied for each paint type are as follows:
   1. Masonry and plastered wall surfaces:
      a. Unless specified otherwise, masonry and plastered wall surfaces shall receive primers and two successive coats.

   2. Wooden surfaces.
      a. Unless specified otherwise, wooden surfaces shall receive primer and two successive coats.
      b. Defects like' open joints, nail holes shall be stopped and surface imperfections faced up after priming. All these remedied areas shall be primed before application of the succeeding coat.
      c. The stopping, filling and facing up of imperfection for wood surfaces to be finished in varnish or clear wood finish shall be in approved wood filler to match the color of the wood or tint of the varnish. Priming of varnish and clear wood finish shall be applied in the joiners shop where practicable but not allowed to stay long before the successive coat is applied.

   3. Metal surfaces:
      a. Unless specified otherwise, metal surfaces shall be coated with.
         1) Two coats of anti-rust primer where coating is not decorative.
         2) Or one coat anti-rust primer and two successive coats of synthetic enamel paint.

   4. Waterproof Cement Coating:
      a. Cement paint shall be applied in two successive coats with no primer. Cement coating shall not be applied under strong direct sun or windy conditions.

F. Surfaces: Unless otherwise specified or shown on the drawings, paint surfaces as follows:
   1. Unless otherwise noted, paint both exterior and interior un-removable and exposed wall and ceiling air supply and return grilles; plumbing pipes; electrical panel and fuse boxes, raceways and conduits; heating convector cabinets, radiators, radiator cabinets, unit heaters, and similar existing and installed devices and equipment by other trades.
      a. Paint to match adjacent wall or ceiling surfaces.
      b. Paint exposed surfaces when any part of the surface is on or within 8 inches of ceiling or wall surface to be painted.
      c. Paint visible interior surfaces behind grilles, guards and screens.

   2. Doors and Frames: Unless otherwise noted, paint doors and frames the same color in the next highest gloss as adjacent wall surfaces.
      a. Where walls are not the same color on both sides of a door frame, change color at the inside corner of the frame stop.
      b. Prime and finish paint door faces and edges before installation.
         1) Paint door edges the same paint type color as the exterior side of the door.

      c. Do not paint door components which are clearly not intended to be painted such as non-ferrous hardware, frame mutes, and weather stripping.
      d. Do not allow doors and frames to touch until paint is thoroughly dry on both surfaces.

3. Window Frames and Sash: Unless otherwise noted, paint window frames and sash the same color as adjacent wall surfaces.
    a. Where interior walls are not the same color on both sides, change paint color along the inside concealed corner of door frame stops.
    b. Do not paint window components which are clearly not intended to be painted such as prefinished frames, sliding metal or plastic contacts, weather-stripping, and non-ferrous hardware.
    c. Do not allow operable doors, windows and frames to touch until paint is thoroughly dry on both surfaces.

4. Ferrous Metal Door and Window Hardware: Unless otherwise noted, prime and paint to match adjacent doors, windows and frames.
5. Case Work: Paint factory unfinished exposed and semi-exposed surfaces when doors and drawers are either open or closed including:
    a. Both faces and edges of cabinet doors, shelving, dividers including interior side, rear, and bottom panel surfaces.
    b. Both faces and edges of drawer face, side, rear, and bottom panels.
    c. Exposed bottom or underside of case work more than 4 feet above the floor.
    d. Do not paint plastic laminate surfaces, special countertop materials, glazing, factory finished surfaces, finish hardware and similar items clearly not intended to be painted.

3.04 FIELD QUALITY CONTROL

A. Paint Samples: Assist the Engineer's Representative in obtaining random one quart paint samples for testing at any time during the Work.
    1. Notify the Engineer's Representative upon delivery of paints to the Site.
    2. Furnish new one quart metal paint containers with tight fitting lids and suitable labels for marking.
        a. Furnish labor to thoroughly mix paint before sampling and provide assistance with sampling when required.

3.05 ADJUSTING AND CLEANING

A. Reinstall removed items after painting has been completed.
    1. Restore damaged items to a condition equal to or better than when removed. Replace damaged items that cannot be restored.

B. Touch up and restore damaged finish paints. Touch up and restoration paint coats are in addition to the number of specified finish paint coats.

C. Remove spilled, splashed, or spattered paint without marring, staining or damaging the surface. Restore damaged surfaces to the satisfaction of the Engineer's representative.

D. Remove temporary barriers, masking tape, and other protective coverings upon completion of painting, cleaning and restoration work.

END OF SECTION

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DIVISION 10 – SPECIALTIES

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SECTION 102800

TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies manufactured items usually used in dressing rooms, toilets, baths, locker rooms and at sinks in related spaces for the following items:
   1. Paper towel dispenser.
   2. Combination paper towel dispenser and disposal unit.
   3. Waste receptacles.
   4. Toilet tissue dispenser.
   5. Grab Bars.
   6. Shower curtain rods.
   7. Clothes hooks, robe or coat.
   8. Towel bars.
   9. Metal framed mirror.
   10. Soap dishes.

1.02 REFERENCES

A. ES ISO 6362: Wrought Aluminum and Aluminum Alloy Extruded Rods/ Bars, Tubes and Profiles.

B. ES ISO 630-1: Structural Steels – Plates, Wide Flats, Bars, Sections and Profiles.

C. ES ISO 1127: Stainless Steel Tubes – Dimensions, Tolerances and Conventional Masses per Unit Length.

D. ES ISO 7598: Stainless Steel Tubes Suitable for Screwing.

E. ES ISO 4998: Continuous Dip Zinc Coated Carbon Steel Sheet of Structural Quality.

F. ES 3122: Specification for Inclusion of Glass in the Construction of Furniture, other than Tables or Trolleys, Including Cabinets, Shelving Systems and Wall Hang or Free Standing Mirrors.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Each product specified.
   2. Show material and finish, size of members, and details of construction, installation and anchorage of mop racks.

B. Samples:
   1. One of each type of accessory specified.
   2. After approval, samples may be used in the work.

C. Manufacturer's Literature and Data:

1. All accessories specified.
2. Show type of material, gages or metal thickness, finishes, and when required, capacity of accessories.
3. Show working operations of spindle for toilet tissue dispensers.

1.04 QUALITY ASSURANCE

A. Each product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.

B. Each accessory type shall be the same and be made by the same manufacturer.

C. Each accessory shall be assembled to the greatest extent possible before delivery to the site.

D. Include additional features, which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging and delivery:
1. Pack accessories individually to protect finish.
2. Deliver accessories to the project only when installation work in rooms is ready to receive them.
3. Deliver inserts and rough-in frames to site at appropriate time for building-in.
4. Deliver products to site in sealed packages of containers; labeled for identification with manufacturer's name, brand, and contents.

B. Storage:
1. Store products in weather tight and dry storage facility.
2. Protect from damage from handling, weather and construction operations before, during and after installation in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless specified in the Contract Documents, the materials specified in the Contract Documents shall comply with the requirements of applicable Referenced Standards.
1. Type, dimensions and color: As indicated.

B. Aluminum:
1. Comply with ES ISO 6362.

C. Stainless Steel Tubes:
1. Comply with ES ISO 1127 and ES ISO 7598.

D. Steel plates, wide flats, bars, sections and profiles:
1. Comply with ES ISO 630-1.

E. Steel Sheet:
   1. Comply with ES ISO 4998.

2.02 FASTENERS

A. Unless specified otherwise comply with the following:
   1. Exposed Fasteners: Stainless steel or chromium plated brass, finish to match adjacent surface.
   2. Concealed Fasteners: Steel, hot-dip galvanized (except in high moisture areas such as showers or bath tubs use stainless steel).
   3. Toggle Bolts: For use in hollow masonry or frame construction.
   4. Hex bolts: For through bolting on thin panels.
   5. Expansion Shields: Lead or plastic as recommended by accessory manufacturer for component and substrate for use in solid masonry or concrete.
   6. Screws: As indicated.
   7. Adhesive: As recommended by manufacturer for products to be joined.

PART 3 EXECUTION

3.01 PREPARATION

A. Before starting work notify Engineer's Representative in writing of any conflicts detrimental to installation or operation of units.

B. Verify with the Engineer's Representative the exact location of accessories.

3.02 INSTALLATION

A. General: Comply with the Contract requirements including the following:

B. Set work accurately, in alignment and where shown. Items shall be plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.

C. Install accessories in accordance with the manufacturer's printed instructions and applicable Referenced Standards.

D. Install accessories plumb and level and securely anchor to substrate.

E. Install accessories in a manner that will permit the accessory to function as designed and allow for servicing as required without hampering or hindering the performance of other devices.

F. Position and install dispensers, and other devices in countertops, clear of drawers, permitting ample clearance below countertop between devices, and ready access for maintenance as needed.

G. Align mirrors, dispensers and other accessories even and level, when installed in battery.

H. Install accessories to prevent striking by other moving, items or interference with accessibility.

3.03 CLEANING

A. After installation, clean as recommended by the manufacturer and protect from damage until completion of the project.

END OF SECTION

DIVISION 22 – PLUMBING

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SECTION 220523

VALVES

PART 1 GENERAL

1.01 REFERENCES

A. EBSC-9-2015: Ethiopian Building Code of Standard – Plumbing Services of Buildings.

B. ES 2603: Safety Valves Part 1. Specification for Safety Valves for Steam and Hot Water.

C. ES 2635: Safety and Control Devices for Use in Hot Water Systems Part 2. Specification For Temperature Relief Valves for Pressures from 1 Bar to 10 Bar.

D. ES ISO 4126-4: Safety Devices for Protection against Excessive Pressure – Part 4: Pilot-operated Safety Valves.

E. ES ISO 1452-4: Plastics Piping Systems for Water Supply and for Buried and above - Ground Drainage and Sewerage under Pressure – Un-plasticized Poly (Vinyl Chloride) (PVC-U) - Part 4: Valves.

F. ES ISO 10497: Testing of Valves - Fire Type - Testing Requirements.

G. ES ISO 5208: Industrial Valves - Pressure Testing of Valves.

H. ES ISO 5209: General Purpose Industrial Valves – Marking.

I. ES ISO 5210:2006: Industrial Valves - Multi-Turn Valve Actuator Attachments.

J. ES ISO 5211: Industrial Valves - Part-Turn Actuator Attachment.

K. ES ISO 5752: Metal Valves for Use in Flanged Pipe Systems - Face-to-Face and Centre – to - Face Dimensions.

L. ES ISO 12149: Bolted Bonnet Steel Globe Valves for General - Purpose Applications.

M. ES ISO 7121: Flanged Steel Ball Valves.

N. ES ISO 5996: Cast Iron Gate Valves.

O. ES ISO 6002: Bolted Bonnet Steel Gate Valves.

P. ES 2612: Building Valves -Water Pressure Reducing Valves and Combination Water Reducing Valves - Requirements and Tests.

Q. ES ISO 10631: Metallic Butterfly Valves for General Purposes.

R. ES 2968: Sanitary Tap-ware - Automatic Shut-off Valves PN 10.

S. ES ISO 6182-2: Fire Protection - Automatic Sprinkler Systems - Part 2: Requirements and Test Methods for Wet Alarm Valves, Retard Chambers and Water Motor Alarms.

T. ES ISO 6182-3: Fire-Protection - Automatic Sprinklers Systems - Part 3: Requirements and Test Methods for Dry Pipe Valves.

U. BS 6675: Specification for Servicing Valves (Copper Alloy) for Water Services.

V. BS 6383: Safety and Control Devices for Use in Hot Water Systems Part 3. Specification For Combined Temperature and Pressure Relief Valves for Pressures from 1 Bar to 10 Bar.

W. ES 2690: Glossary of Building and Civil Engineering Terms. Services. Sanitation.

1.02 DEFINITIONS

A. The terms explained under this section shall comply with the terms and definitions stated in ES 2690 including the following:
   1. Servicing valve: A valve intended to facilitate maintenance or servicing of a water fitting or appliance.

1.03 SUBMITTALS

A. Product Data: Manufacturer’s catalog sheets and specifications for each valve type.

B. Valve Schedule: List type of valve, manufacturer’s model number, and size for each service application.

1.04 DELIVERY, STORAGE AND HANDLING

A. Valves shall be prepared for storage as follows:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature.

PART 2 PRODUCTS

2.01 VALVES - GENERAL

A. Valve Standardization:
   1. Valves from one or more manufacturers may be used, however valves supplied for each specific valve type shall be the product of one manufacturer.

B. Valves shall be approved quality, free from all imperfections and defects, with body markings indicating manufacturer and rating.

C. Valve parts of same manufacturer, size and type shall be interchangeable.

D. Manually operated gate, globe and angle valves shall be of rising stem type, unless otherwise specified.

E. Valves which use packing shall be capable of being packed when wide open and under full working pressure.

F. Size valves the same size as the piping in which they are installed, unless specified otherwise.

2.02 GATE VALVES

A. Cast Iron Gate Valves: Shall comply with the requirements of ES ISO 5996.

B. Bolted Bonnet Steel Gate Valves: Shall comply with the requirements of ES ISO 6002.

2.03 GLOBE AND ANGLE VALVES

A. Bolted Bonnet Steel Globe Valves for General - Purpose Applications: Shall comply with the requirements of ES ISO 12149.

2.04 PVC-U VALVES

A. PVC-U Valves used for plastics piping systems for water supply and for buried and above - ground drainage and sewerage under pressure shall comply with the requirements of ES ISO 1452-4.

2.05 SERVICING VALVES

A. Servicing Valves (Copper Alloy) for Water Services: Shall comply with the requirements of BS 6675.

2.06 BUTTERFLY VALVES

A. Metallic Butterfly Valves for General Purposes: Shall comply with the requirements of ES ISO 10631.

2.07 WATER PRESSURE REDUCING VALVES

A. Water Pressure Reducing Valves and Combination Water Reducing Valves: Shall comply with the requirements of ES 2612.

2.08 SAFETY AND RELIEF VALVES

A. Safety Valves for Steam and Hot Water: Shall comply with the requirements of ES 2603.

B. Temperature Relief Valves for Pressures from 1 Bar to 10 Bar: Shall comply with the requirements of ES 2635.

C. Combined Temperature and Pressure Relief Valves for Pressures from 1 Bar to 10 Bar: Shall comply with the requirements of BS 6383.

D. Pilot-operated Safety Valves: Shall comply with the requirements of ES ISO 4126-4.

2.09 BALL VALVES

A. Flanged Steel Ball Valves: Shall comply with the requirements of ES ISO 7121.

PART 3 EXECUTION

3.01 EXAMINATION

A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.

B. Valves shall be operated in positions from fully open to fully close.

C. Threads on valve and mating pipe shall be examined for form and cleanliness.

D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 INSTALLATION

A. General:
   1. Install valves at locations noted on the Drawings or specified.
      a. Consider the requirements of EBSC-9-2015 for the need and appropriate location of valve installation.

B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.

C. Check valves shall be installed for proper direction of flow.

END OF SECTION

SECTION 221100

PLUMBING PIPING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Sealants: Section 079200.

1.02 REFERENCES

A. EBSC-9-2015: Ethiopian Building Code of Standard – Plumbing Services of Buildings.

B. BS 8000-15: Workmanship on Building Sites. Part 15. Code of Practice for Hot and Cold Water Services (Domestic Scale).

C. ES 1662: Workmanship on Building Sites. Code of Practice above Ground Drainage and Sanitary Appliances.

D. BS 534: Specification for Steel Pipes, Joints and Specials for Water and Sewerage.

E. BS 4127: Specification for Light Gauge Stainless Steel Tubes, Primarily for Water Applications.

F. ES 2716: Specification for Design, Installation, Testing, and Maintenance of Services Supplying Water for Domestic Use within Buildings and their Curtilages.

G. ES 2625: Welded Stainless Steel Tubes for the Conveyance of Aqueous Liquids Including Water for Human Consumption Technical Delivery Conditions.

H. ES ISO 1127: Stainless Steel Tubes – Dimensions, Tolerances and Conventional Masses per Unit Length.

I. ES ISO 4144: Pipework – Stainless Steel Fittings Threaded in Accordance with ISO 7-1.

J. ES ISO 5251: Stainless Steel Butt-Welding Fittings.

K. ES ISO 3419: Non-Alloy and Alloy Steel Butt-Welding Fittings.

L. ES ISO 4145: Non-Alloy Steel Fittings Threaded to ISO 7/1.

M. ES ISO 49: Malleable Cast Iron Fittings Threaded to ISO 7-1.

N. ES ISO 7005-1: Metallic Flanges – Part 1: Steel Flanges.

O. ES ISO 7005-2: Metallic Flanges – Part 2: Cast Iron Flanges.

P. ES ISO 7005-3: Metallic Flanges – Part 3: Copper Alloy and Composite Flanges.

Q. ES ISO 4179: Ductile Iron Pipes and Fittings for Pressure and Non-Pressure Pipelines – Cement Mortar Lining.

R. ES ISO 2531: Ductile Iron Pipes, Fittings, Accessories and their Joints for Water or Gas Applications.

S. ES ISO 4427-2: Plastics Piping Systems – Polyethylene (PE) Pipes and Fittings for Water Supply – Part 2: Pipes.

T. ES ISO 4427-3: Plastics Piping Systems – Polyethylene (PE) Pipes and Fittings for Water Supply – Part 3: Fittings.

U. ES 2705: Specification for Performance Requirements for Joints and Compression Fittings for Use with Polyethylene Pipes.

V. ES ISO 8772: High-Density Polyethylene (PE-HD) Pipes and Fittings for Buried Drainage and Sewerage Systems – Specifications.

W. ES ISO 1452-2: Plastics Piping Systems for Water Supply and for Buried and Above-Ground Drainage and Sewerage Under Pressure – Un-plasticized Poly (Vinyl Chloride) (PVC-U) – Part 2: Pipes.

X. ES ISO 1452-4: Plastics Piping Systems for Water Supply and for Buried and Above-Ground Drainage and Sewerage Under Pressure – Un-plasticized Poly (Vinyl Chloride) (PVC-U) – Part 4: Valves.

Y. ES ISO 3633: Plastics Piping Systems for Soil and Waste Discharge (Low and High Temperature) Inside Building – Un-plasticized Poly (Vinyl Chloride) (PVC-U).

Z. ES ISO 7671: Plastics Piping Systems for Soil and Waste Discharge (Low and High Temperature) Inside Building – Polypropylene (PP).

AA. ES 2690: Glossary of Building and Civil Engineering Terms. Services. Sanitation.

1.03 DEFINITIONS

A. The terms of sanitary appliances explained under this section shall comply with the terms and definitions stated in ES 2690 and the following:
   1. Pipe: Circular tube through which fluid can flow.
   2. Water fitting: Component associated with supply, distribution and use of water, apart from its disposal.
   3. Pipe fitting: Component fitted to a pipe for such purposes as connecting, supporting or changing the direction or bore.
   4. Coupling: Pipe fitting or channel fitting that is used to form a connection.
   5. Bend: Curved pipe fitting or channel fitting for changing the direction of flow, or curve set in a pipe.
   6. Branch fitting: Pipe fitting or channel fitting that connects one or more branches to a main pipe or channel.
   7. Elbow: Pipe fitting that provides a sharp change of direction.
   8. Tap: Small diameter manually operated valve, with draw-off tap deprecated a free outlet, from which water is drawn.

1.04 SUBMITTALS

A. Product Data:
   1. Catalog sheets and specifications indicating manufacturer name, type, applicable reference standard, schedule, or class for specified pipe and fittings.
   2. Material Schedule: Itemize pipe and fitting materials for each specified application in Pipe and Fittings Schedule. Where optional materials are specified indicate option selected.

B. Quality Control Submittals
   1. Copy of hydraulic press fitting manufacturer's printed field inspection procedures for hydraulic press joints in copper tubing.
   2. Qualification Data: Copies of certificates of the supervisors include their addresses.

1.05 QUALITY ASSURANCE

A. Qualification: Comply with the following:
   1. The supervisor having good experience and qualification in plumbing piping works with minimum experience of 3 years.

1.06 DELIVERY, STORAGE AND HANDLING

A. General:
   1. All means necessary to protect piping and other sanitary material during transport and before, during and after installation shall be provided to ensure that no damage occurs to the materials, and coatings.
   2. Where damage to material or surface occurs, repairs shall be made or, if unacceptable, replaced as required. Sanitary ware shall be supplied in their original packing.

B. Storage:
   1. Pipes shall be stacked on level ground to ensure that no pipes rest on sockets or other joints. End of pipes in bottom rows shall be securely chocked to prevent collapse of stack.
   2. Pipes shall, as far as possible, be stacked **in** pyramid form and to a maximum height of 2000mm above ground.

PART 2 PRODUCTS

2.01 PIPES AND FITTINGS

A. General:
   1. All pipes and fittings for water supply system shall comply with the requirements of EBSC-9-2015.

B. Plastic pipes: The materials specification for plastic pipes made from un-plasticized poly (vinyl chloride) (PVC-U), polyethylene (PE), high density polyethylene (HDPE) or polypropylene (PP) are specified in this Section hereunder and in addition to these, the following requirements shall also be maintained:
   1. Plastic pipes shall not be installed close to source of heat or in direct sunlight; otherwise their performance is impaired.

2. Where pipes are installed above ground, consideration shall be given to accommodate thermal movements.
3. As un-plasticized PVC pipes become increasingly brittle with reducing temperatures, particular care should be taken in handling them in temperatures below 5°C.

2.02 STEEL PIPE AND FITTINGS

A. Stainless steel:
1. Stainless steel tubing for the application of water for domestic use shall conform to BS 4127.
   a. Stainless steel tubes shall not be joined by soft solder.

2. Welded stainless steel tubes for the application of water for domestic use shall conform to ES 2625.
3. Fittings:
   a. Stainless steel fittings threaded in accordance with ISO 7-1: Comply with ES ISO 4144.
   b. Stainless steel butt-welding fittings: Comply with ES ISO 5251.

4. Dimensions, tolerances and conventional masses per unit length of stainless steel tubes: Comply with ES ISO 1127.

B. Steel:
1. Steel pipes shall conform to BS 534.
   a. Galvanized steel pipe shall be jointed only by screwed connections; under no circumstances shall welded or brazed joints be used because this would damage the galvanizing.
   b. Site bending of galvanized tube will also damage the galvanizing; in view of this or where it is necessary to change direction pre-formed bends shall be used.
   c. Galvanized tubes offer only marginal protection against corrosion, and shall be protected from corrosion especially where installed below ground.

2. Fittings:
   a. Non-alloy and alloy steel butt-welding fittings: Comply with ES ISO 3419.
   b. Non-alloy steel fittings threaded to ISO 7/1: Comply with ES ISO 4145.

3. Steel Flanges: Comply with ES ISO 7005-1.

C. Seamless and welded carbon steel pipes or specials: complying with the requirements stated in BS 534:
1. The pipes or specials unless specified otherwise shall be manufactured and supplied as per the following information;
   a. The method of manufacture of the pipe or special & the grade of steel required;
   b. The dimension of the pipe or special;
   c. The cutting or random length required;
   d. Type of joint required;
   e. Type of flange required;
   f. Type of specials required;
   g. Corrosion protection requirements;
   h. Maximum working pressure.

2. The pipe ends shall be prepared, as appropriate, for one of the following type of joints as required by the Contract Documents:
   a. Butt-welded joints;
   b. Sleeve joints for welding;
   c. Slip-on type coupling;
   d. Flange joints;
   e. Screwed and coupled joints.

3. Protection against corrosion:
   a. The external and internal protection of pipes and specials against the corrosive action of the surrounding medium and conveyed fluid shall be maintained as per the requirements.

2.03 COPPER PIPE, TUBING AND FITTINGS

A. General:
   1. Copper is generally resistant to corrosion and is suitable for hot and cold water applications. Where supply waters are capable of dissolving an undue amount of copper such that either.
      a. Unacceptable green staining is produced, or
      b. Deposition of copper into aluminum or zinc surface promotes galvanic attack.
         1) Consideration shall be given to the use of alternative materials.

   2. Galvanized steel pipe work should not be used connected to and, especially, downstream from copper pipe work; otherwise it will be subjected to accelerated corrosion.

B. Copper tube: Comply with ES 2716.

C. Copper tube fittings: Comply with ES 2716.

D. Copper alloy and composite flanges: Comply with ES ISO 7005-3.

2.04 CAST IRON PIPE AND FITTINGS

A. Cast Iron pipe: Comply with applicable Standards.

B. Cast Iron Fittings:
   1. Malleable cast iron fittings threaded to ISO 7-1: Comply with ES ISO 49.
   2. Cast Iron Flanges: Comply with ES ISO 7005-2.

2.05 DUCTILE IRON PIPE AND FITTINGS

A. Ductile iron pipes, fittings, accessories and their joints for water or gas applications:
   1. Shall comply with ES ISO 2531.

B. Cement Mortar Lining:
   2. The cement mortar lining for ductile iron pipes and fittings for pressure and non-pressure pipelines shall comply with ES ISO 4179.

2.06 UN-PLASTICIZED POLY (VINYL CHLORIDE) (PVC-U) PIPING AND FITTINGS

A. Pipe: Comply with ES ISO 1452-2 for water supply and for buried and above-ground drainage and sewerage under pressure.

B. Valves: Comply with ES ISO 1452-4 for water supply and for buried and above-ground drainage and sewerage under pressure.

C. Comply with ES ISO 3633 for soil and waste discharge (low and high temperature) inside building.

2.07 POLYETHYLENE (PE) PIPING AND FITTINGS

A. Water supply:
   1. Pipe: Comply with ES ISO 4427-2.
   2. Fittings: Comply with ES ISO 4427-3.

2.08 HIGH DENSITY POLYETHYLENE (HDPE) PIPING AND FITTINGS

A. Buried drainage and sewerage systems: Comply with ES ISO 8772 for both pipes and fittings.

2.09 POLYPROPYLENE (PP) PIPING AND FITTINGS

A. Comply with ES ISO 7671 for soil and waste discharge (low and high temperature) inside building.

2.10 COATING AND LINING MATERIALS

A. No pipe, pipe fitting or storage cistern intended for conveying or storing water shall be lined or coated internally with coal, tar or any substance that includes coal-tar.

B. Recommendations for the protective coating against corrosion of iron and steel pipes, fittings and cisterns shall be complied with the requirements of Referenced Standards.

2.11 PIPE SLEEVES

A. Unless otherwise shown, comply with applicable Referenced Standards for the type and size of sleeve to be used where piping penetrates wall or floor construction.

2.12 FLOOR, WALL AND CEILING PLATES

A. Cast Brass: Solid type with polished chrome plated finish, and set screw, unless shown otherwise.

B. Stamped Steel: Split type, polished chrome plated finish, with set screw, unless shown otherwise.

C. Cast Iron or Malleable Iron: Solid type, galvanized finish, with set screw, unless shown otherwise.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Unless specified otherwise, installation of each type of pipes and fittings shall comply with the requirements of applicable Referenced Standards.
   1. All materials and components used for the construction of piping system shall be handled with sufficient care and attention to prevent their deterioration. Such deterioration may impair their serviceability of affect the performance of the system and shall be rejected.
   2. All piping and fittings shall be cleaned internally and shall be free from particles of sand, soil, metal filings and chips.

B. Joining of pipes:
   1. Satisfactory joining techniques shall be established for all types of pipework and care shall be taken especially for water pipework.
   2. No metal pipe shall be connected to any other pipe or water fitting by means of adhesive in any case where the metal pipe is:
      a. Installed in the ground or passes through or under any wall footing or foundation.
      b. Embedded in a wall or solid floor.
      c. Enclosed in a chase or duct.
      d. In a position where access is difficult.

   3. Piping laid through notched, holes or chases shall not be subjected to external pressure and shall be free to expand or contract. Piping though walls and floors shall be sleeved.
   4. Install piping at approximate locations indicated, and at maximum height.
   5. Make allowances for expansion and contraction.
   6. Allow for a minimum of one inch free air space around pipe or pipe covering, unless otherwise specified.
   7. Install horizontal piping with a constant pitch, and without sags or humps as per the requirements of applicable Referenced Standards.
   8. Install vertical piping plumb.
   9. Use fittings for offsets and direction changes as per the requirements of applicable Referenced Standards.

C. Support & fixing of pipes:
   1. General:
      a. Piping shall be retained in position by brackets, clips or hangers.
      b. Brackets, clips and hangers shall be:
         1) Formed of suitable materials.
         2) Securely attached to the building structure, and not to any other service.
         3) Designed to withstand the applied loads.
         4) Protected against corrosion where exposed to corrosive environment.
         5) Of like material or lined with a non-abrasive, inert material for that section where contact with the pipe work many occur.
         6) Installed so that no movement can occur while a valve is operated.

c. The method of supporting of spacing of pipes by means of brazing or welding a short section of any material to the surface of each pipe shall not be permitted.

2. Spacing for pipe fixings:
   a. The spicing for fixings of internally located piping shall be in accordance with the requirements stated in EBSC-9-2015.

3. Fixing of iron pipe:
   a. Iron pipes shall be secured by heavy weight holder-bats of iron or low carbon steel either built in or bolted to the structure.

4. Fixings for copper and stainless steel pipe:
   a. Copper and stainless steel piping shall be secured by copper, copper-alloy, plastics clips or brackets.

5. Fixings for steel pipe:
   a. Steel piping shall be secured by steel, copper alloy, suitable plastics clips or brackets. Copper clips or brackets shall not be used for fixing steel piping.

6. Fixing for plastic pipes:
   a. Plastics piping shall be secured by suitable metal, plastic lips or brackets. Allowance shall be made for free lateral movement within the clips and brackets.

7. Fixing of insulated pipes:
   a. Piping that is insulated shall be secured on clips or brackets that allow sufficient space behind the back of the pipe and the batten or wall to which the pipe is fixed for the insulation to be properly installed.

8. Concealed pipes:
   a. Piping shall be housed in properly constructed builder work ducts or wall chases with adequate supports and have access for maintenance and inspection in accordance with the requirements stated in EBSC-9-2015.

3.02 DRAINAGE SYSTEMS

A. Fittings:
   1. Fittings shall be installed to guide sewage and waste in the direction of flow.
   2. Change in direction shall be made by fittings installed in accordance with the requirements stated in EBSC-9-2015.
   3. Change in direction by combination fittings, side inlets or increasers shall be installed in accordance with the requirements stated in EBSC-9-2015 based on the pattern of flow created by the fitting.

B. Cleanouts:
   1. Cleanout plugs shall be brass or plastic, or other approved materials.
   2. Brass cleanout plugs shall be utilized with metallic drain, waste and vent piping only, Cleanouts with plate-style access covers shall be fitted with corrosion-resisting fasteners.
   3. Plastic cleanout plugs shall conform to the requirements.
   4. Plugs shall have raised square or countersunk square heads.
   5. Countersunk heads shall be installed where raised heads are a trip hazard.

6. Cleanout plugs with borosilicate glass systems shall be of borosilicate glass.
7. Unless specified otherwise, cleanouts shall be located in accordance with the requirements stated in EBSC-9-2015.

3.03 DOMESTIC WATER PIPING SYSTEM

A. All joints shall be gas-tight and water-tight, and no paint, varnish, or putty shall be permitted on the joint until after the joint has been tested and approved.

B. Make final connections to plumbing fixtures and equipment with unions, or flanges as indicated or in accordance with the requirements of the Referenced Standards.

3.04 FIRE SPRINKLER AND FIRE STANDPIPE PIPING SYSTEM

A. Install piping to be completely drainable.

3.05 PIPE JOINT MAKE-UP

A. Threaded joint: Make up joint with a pipe thread compound applied in accordance with manufacturer's printed application instructions for the intended service.

B. Soldered joint: Thoroughly clean tube end and inside of fitting with emery cloth, sand cloth, or wire brush. Apply flux to the pre-cleaned surfaces. Install fitting, heat to soldering temperature, and join the metals with type solder specified. Remove residue.

C. Flanged Pipe Joint:
1. Install threaded companion flanges on steel pipe; flanges on galvanized pipe are not required to be galvanized.
2. Provide a gasket for each joint.
3. Coat bolt threads and nuts with anti-seize lubricant before making up joint.

D. Rubber ring push-on joint: Clean hub, bevel spigot, and make up joint with lubricated gasket in conformance with the manufacturer's printed installation instructions.

E. Grooved pipe joint: Roll groove pipe ends, make up joint with grooved end fittings and couplings, in conformance with the manufacturer's printed installation instructions.
1. Cut grooved end piping is not acceptable.

F. Mechanical joint: Make up joint in conformance with the manufacturer's printed installation instructions, with particular reference to tightening of bolts.

G. Polyethylene containment pipe joint: Follow manufacturer's printed installation instructions.

H. High density polyethylene pipe joint (HDPE): Follow manufacturer's printed installation instructions.

I. Hydraulic pressed joint: Follow manufacturer's printed installation instructions.

J. Dissimilar pipe joint:
1. Joining dissimilar threaded piping: Make up connection with a threaded coupling or with companion flanges.

2. Joining dissimilar non-threaded piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.
3. Joining galvanized steel pipe and copper tubing: Make up connection with a dielectric connector.

3.06 PIPING PENETRATIONS

A. Sleeve Schedule:
   1. It shall be capable of resisting external loading and shall be sealed at each end with material of permanently flexible form to allow movement of the pipe.
   2. The diameter of the sleeve and the radius of any bends there in shall be such as to permit the ready insertion and withdrawal of the pipe.
   3. No sleeve intended for carrying a water pipe shall contain within it any other pipe or cable.

3.07 FLOOR, WALL AND CEILING PLATES

A. Install plates for exposed uninsulated piping passing thru floors, walls, ceilings, and exterior concrete slabs in accordance with the requirements of the Referenced Standards.

3.08 UNDERGROUND PIPE LAYING

A. Trench excavations:
   1. The bottom of trenches shall be carefully prepared to a firm surface so that the barrels of the pipes, when laid, are well bedded for their whole length.
   2. Mud, rock projections, boulders, hard sport and local soft spots shall be removed and replace with selected material consolidated to the required level.
   3. Pipes laid in the ground shall be provided with a minimum cover of 750 mm for pipes subject to vehicular traffic and 600 mm for all other locations measured from ground surface level as given in EBSC-9-2015.

B. Bedding and backfilling:
   1. In the refilling of trenches, the pipes shall be surrounded with not less than 75.0 mm of compacted sand, or fine grained soil, with no hard-edged object permitted to come in contact with or rest against any pipe or fitting.
   2. Any back fill within 300.0 mm of the top of the pipe shall be free from builder's waste bricks, concrete pipes, rocks or similar material which would be retain on a 75.0 mm sieve.
   3. For pipes to be buried in heavy truck areas, special consideration shall be taken to protect them from damage.

C. Proximity to other services:
   1. Electrical cables and gas pipes shall not be installed within 600.0mm of either side of a below ground water service. Wherever this separation cannot be achieved, the distance from any electrical cable or gas pipe may be reduced to 300.0mm provided that, within the exclusion zone, such electrical cable or gas pipe is suitably marked with bricks, stone masonry or equivalent durable material painted red.
   2. Any below-ground cross-over of water service, within the exclusion zone, shall:
      a. Cross at angle not less than 45°.
      b. Have a vertical separation of not less than 100.0 mm.

c. Be suitably marked with bricks, stone masonry or equivalent durable material, painted red.

3. Water service pipes shall not be laid in a trench excavated for a foul drain. Wherever it is not practical to do otherwise, water pipes may be laid in the same trench as a sanitary drain provided the following conditions are observed:
   a. The water service shall be located on a shelf or ledge, excavated at one side of the trench not less than 50.0mm from the continuation of the trench, or on compacted bedding.
   b. The underside of the water pipe is at least 100.0mm above the top of foul drain.
   c. The number of joints in the water service pipe shall be kept at a minimum.
   d. Ingress of dirt:
   e. Pipes shall be kept clean and, immediately before laying each pipe and fitting, shall be thoroughly cleaned internally and the open end temporarily capped until jointing takes place. Particular care shall be taken to keep the joints clean. After laying and jointing, the leading end shall remain capped.

D. Corrosion:
   1. Pipes passing through corrosive materials shall be provided with approved coatings, sheathings or wrappings or other means of protection against damage from external corrosion.
   2. Where ferrous and non-ferrous pipes or fittings are jointed together, protection against galvanic corrosion shall be provided by:
      a. Fitting a plastic connector or a short length of plastic pipe between the dissimilar metals, for threaded type joints, or
      b. Fitting an insulated gasket between flanges, insulating sleeves along the bolts, and insulating washers under the bolt head and nut, for flange type joints.

E. Thrust blocks:
   1. Thrust bocks shall be installed at:
      a. All bends or junctions.
      b. The termination of pipe work.
      c. Valves installed in the pipe work.
      d. The reducing fitting in the direction of smaller pipe.
      e. Changes of direction in excess of 5°, and
      f. Grades in excess of 1:5.

   2. Thrust blocks shall be constructed of concrete with one side bearing against a firm vertical face of the excavation and designed to resist the thrust produced by the test pressure to be transmitted to the surrounding soil without the maximum bearing pressures of the soil and the pipe work material being exceeded.

3.09 FIELD QUALITY CONTROL

A. General: Comply with the requirements of EBSC-9-2015 for the following:
   1. Inspection and testing procedures for pipes and fitting works.
   2. Cleaning and disinfection of storage tanks for potable water.
   3. Maintenance procedures for pipes and fittings.

B. Water supply and drainage works shall be tested in sections as directed after laying and jointing and before being covered up. The test shall be repeated after the pipes are covered up.

C. The length of pipes to be installed shall be such that they pass tests before and after being covered up. Valves and taps shall be broken down, lubricated and reassembled before final fixing.

D. Pipe line shall be cleaned before testing.

E. The water to be used for testing shall be clean potable water. The equipment and testing methods for pipe tests shall he subject to prior approval.

F. External water service pipes shall be subjected to a hydraulic test pressure of at least two times the working pressure at the lowest points of the pipe line section under test and maintained for a period of one hour.

G. Drainage pipe work shall be subjected to a hydraulic test pressure of 3000mm head over the highest fitting level, maintained for a minimum period of 4 hours.

H. Internal water service pipe shall be subjected to an air test pressure of 10 bar, maintained for a period of 15 minutes.

I. At completion of testing, defects in pipe lines shall be made good and taps and valves checked for satisfactory flow and closing.

END OF SECTION

Ministry of Construction

SECTION 223300

ELECTRIC DOMESTIC WATER HEATERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section describes the requirements for factory manufactured instantaneous and non-instantaneous electric water heaters for domestic use. It includes the requirements for insulated water heaters for long-term hot water storage and un-insulated for temporary storage of heated water in a container.

1.02 REFERENCES

A. BS 699: Specification for Copper Direct Cylinders for Domestic Purposes.

B. BS 1565: Specification for Galvanized Mild Steel Indirect Cylinders Annular or Saddle-back Type.

C. BS 1566: Copper Indirect Cylinders for Domestic Purposes.

D. BS 3198: Specification for Copper Hot Water Storage Combination Units for Domestic Purposes.

E. BS 3456-2-21: Specification for the Testing and Approval of Household Electrical Appliances. Part 2. Particular Requirements: Section 2.21 Electric Immersion Heaters.

F. EN 60335-1: Household and Similar Electrical Appliances – safety – Part 1: General Requirements

G. EN 60335-2-21: Specification for Safety of Household and Similar Electrical Appliances: Part 2. Particular Requirements: Section 2.21 Storage Water Heaters.

H. EN 60335-2-35: Specification for Safety of Household and Similar Electrical Appliances: Part 2.35 Particular Requirements for Instantaneous Water Heaters.

I. EN 50193: Closed Electrical Instantaneous Water Heaters – Methods for Measuring Performance.

J. ES 2690: Glossary of Building and Civil Engineering Terms. Services. Sanitation.

1.03 DEFINITIONS

A. The terms under this section shall comply with the terms and definitions stated in ES 2690 and the following:
   1. Primary heater: Heater exchanger mounted inside a cylinder for transfer of heat to stored water from circulating primary hot water or steam.
   2. Water heater: Device or appliance for heating water.
   3. Instantaneous water heater: Water heater in which water is immediately heated to a required temperature as it passes through the appliance.

4. Storage water heater: A stationary appliance for heating water in a container intended for long-term or temporary storage of the heated water and provided with devices to control or limit the water temperature.
5. Closed water heater: A storage water heater designed to operate under the pressure of the water supply main, the flow of water being controlled by one or more valves in the outlet system.
6. Water tank: Closed non-cylindrical vessel for storing water under pressure.
7. Cistern: Fixed container for holding water at atmospheric pressure.
8. Cylinder: A closed cylindrical vessel with domed ends for storing water under pressure.

1.04 SUBMITTALS

A. Product Data: Submit catalog sheets, specifications and installation instructions for each electric domestic water heater.

B. Quality assurance certificate:
   1. Submit quality assurance certificate of the manufacturer for each electric domestic water heater.

C. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Engineer's Representative.
   2. Submit accepted Warranty for Electric Domestic Water Heaters to the Procuring Entity.

1.05 QUALITY ASSURANCE

A. All electric domestic water heaters shall be certified and labeled by a recognized testing agency.

1.06 SAFETY REQUIREMENTS

A. General: The safety requirements stated in applicable Referenced Standards, especially in EN 60335, shall be complied for all Electric Domestic Water Heaters.

1.07 WARRANTY

A. Five years warranty from the date of substantial completion for the Electric Domestic Water Heaters.

PART 2 PRODUCTS

2.01 ELECTRIC DOMESTIC WATER HEATERS

A. General: Unless indicated in the Contract Documents, all the materials and components of Electrical Domestic Water Heaters shall comply with the requirements of relevant Referenced Standards.

B. Water Heaters manufactured from copper cylinder shall comply with the requirements of BS 699 for Direct Copper Cylinder, BS 1566 for Indirect Copper Cylinder and BS 3198

for Copper Hot Water Storage Combination Units including the following compliance with respect to the referred Standards.

1. The size of cylinder, the grade and the thickness of material appropriate to each grade.
2. The maximum permissible heat loss to be maintained for factory insulated cylinder after testing.
3. The requirements to be maintained for insulating material.
4. Screwed connections requirements.

C. Closed Electrical Instantaneous Water Heaters: Comply with the requirements of EN 50193.

D. Water Heaters manufactured from galvanized mild steel indirect cylinders annular or saddle-back type shall comply with the requirements BS 1565.

2.02 SOURCE QUALITY CONTROL

A. Test requirements:
   1. General: All Electrical Domestic Water Heaters shall fulfill the minimum test requirements as stated in applicable Referenced Standards.

B. Verification of performance:
   1. Marking: Every Electrical Domestic Water Heaters shall be permanently and clearly marked by stamping, embossing or etching on the body of the appliance or on an appropriate metal plate soldered to the body of the appliance, with the information stated in relevant Referenced Standards including the following:
      a. The number and date of the relevant Standard that the product has been manufactured to the requirements of the Standard followed by the Standard type reference and grade.
      b. Manufacturer's name or identification mark.
      c. The maximum permissible working head of the appliance, as required.
      d. The storage capacity, as required.
      e. Others as required by the relevant Referenced Standards.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions, unless otherwise specified.

B. Install the water heater on a level, firm base unless elevated above the floor.

C. The water heaters shall be installed level and plumb and securely anchored.

D. Install the pressure-temperature relief valve in the dedicated tank tapping. All pressure and temperature relief valves discharge shall be piped to nearby floor drains or pipe the relief valve blow-off to a point 15 cm above the floor as appropriate.

E. Provide gate valves on hot and cold water connections.

F. Make final piping connections with unions.

G. Flush and fill water heater cylinder or tank. Do not switch on heating elements until cylinder or tank is full and entrapped air is eliminated.

END OF SECTION

SECTION 224200

PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Sealants: Section 079200.

1.02 REFERENCES

A. EBSC-9: Ethiopian Building Code of Standard – Plumbing Services of Buildings.

B. ES 2690: Glossary of Building and Civil Engineering Terms. Services. Sanitation.

C. ES 2645: Specification for Quality of Vitreous China Sanitary Appliances.

D. ES 1662: Workmanship on Building Sites. Code of Practice above Ground Drainage and Sanitary Appliances.

E. ES 2651: Baths made from Porcelain Enameled Cast Iron.

F. ES 2663: Baths for Domestic Purposes made of Acrylic Material Part 1: Specification for Finished Baths.

G. ES 2662: Baths for Domestic Purposes made of Acrylic Material Part 2: Specification for Connecting Dimensions.

H. ES 2598: Baths Connecting Dimensions.

I. BS 1390: Specification for Baths made from Vitreous Enameled Sheet Steel.

J. ES 2912: Shower Units-Part 6: Specification for Prefabricated Shower trays made from Porcelain Enameled Cast Iron.

K. ES 2717: Shower Units. Specification for Prefabricated Shower trays made from Acrylic Material.

L. ES 2914: Shower Units-Part 8: Specification for Prefabricated Shower trays made from Glazed Ceramic.

M. ES 2704: Shower Units. Specification for Shower Heads and Related Equipment.

N. ES 2701: Shower Units. Specification for the Installation of Shower Units. Part-1.

O. ES 2601: Shower Trays Connecting Dimensions.

P. ES 2650: Kitchen Sinks-Functional Requirements and Test Methods.

Q. ES 1342: Specification for Fireclay Sinks: Dimensions and Workmanship.

R. ES 2937: Kitchen Sinks – Connecting Dimensions.

S. ES 2892: Specification for WC Flushing Cisterns (Including Dual Flush Cisterns and Flush Pipes).

T. ES 2579: Float Operated Valves Part 4: Specification for Compact Type Float Operated Valves for WC Flushing Cisterns (Including Floats).

U. ES 2649: Specification for WC Seats (Plastics).

V. ES 2584: Vitreous China Wash Down WC Pans with Horizontal Outlet Part 2. Materials Quality Performance and Dimension.

W. ES 2586: Specification for Wall Hang WC Pan Part 1. Wall Hang WC Pan with Close Coupled Cistern. Connecting Dimensions.

X. ES 2585-3: Vitreous China Wash Down WC Pans with Horizontal Outlet Part-3: Specification for WC Pans with Horizontal Outlet for use with 7.5 L Maximum Flush Capacity Cisterns.

Y. ES 2589: Plastic Connectors for use with Horizontal Outlet Vitreous China WC Pans.

Z. ES 2590: Specification for 7.5 L WC Flushing Cisterns.

AA. ES 2672: WC Pans and WC Suites with Integral Trap.

BB. ES 2688: Specification for Wall Hang WC Pan Part 2. Wall Hang WC Pan with Independent Water Supply. Connecting Dimensions.

CC. ES 2648: Specification for Automatic Flushing Cisterns for Urinals.

DD. ES 2588: Vitreous China Bowl Urinals (Rimless Type).

EE. ES 2596: Wall-Hang Urinals – Connecting Dimensions.

FF. ES 2661: Specifications: for Urinals Stainless Steel Slab Urinals.

GG. ES 2595: Wall Hang Bidets with Over-rim Supply Connecting Dimensions.

HH. ES 2904: Specification for Bidets Part 3: Vitreous China Bidets over Rim Supply only. Quality, Workmanship and Functional Dimensions other than Connecting Dimension.

II. ES 2652: Specification for Ceramic Wash Basins and Pedestals.

JJ. ES 2587: Specification for Wash Basins Part 3. Wash Basins (One or Three Tap Holes). Material Quality, Design and Construction.

KK. ES 2592: Pedestal Wash Basins Connecting Dimensions.

LL. ES 2593: Wall-Hang Wash Basins Connecting Dimensions.

MM. BS EN 274-1: Waste Fittings for Sanitary Appliances – Part 1: Requirements.

NN. BS 1244-2: Metal Sinks for Domestic Purposes – Part 2: Specification for Sit-on and Inset Sinks.

OO. ES 2577: Float Operated Valves Part 2: Specification for Diaphragm Type Float Operated Valves (Copper Alloy Body) (Excluding Floats).

PP. ES 2578: Float Operated Valves Part 3: Specification for Diaphragm Type Float Operated Valves (Plastic Bodied) for Cold Water Services Only (Excluding Floats).

QQ. BS 6340-7: Shower Units-Part 8: Specification for Prefabricated Shower trays made from Vitreous Enameled Sheet Steel.

1.03 DEFINITIONS

A. The terms of sanitary appliances explained under this section shall comply with the terms and definitions stated in ES 2690 and the following:

B. Sanitary appliance: Fixed appliance, usually supplied with water, used for drinking, cleaning or waste water disposal

C. Complying with the definitions stated in ES 2651:
   1. Porcelain enamel: a glazed surface finish produced by the application of a powdered inorganic glass, dry or suspended in water, to cast iron parts, and its subsequent fusion.

D. Complying with the definitions stated in ES 2645:
   1. Vitreous china: a strong high-grade ceramic ware used for sanitary appliances and made from a mixture of white burning clays and finely-ground minerals which, after firing at high temperature and when tested in accordance with the test methods, does not have a mean value of water absorption greater than 0.5% of the dry weight. It is coated on all exposed surfaces with an impervious non-crazing vitreous glaze giving a white or colored finish.

E. Complying with the definitions stated in BS 1390:
   1. Vitreous enamel: a glazed surface finish produced by the application of a powdered inorganic glass, dry or suspended in water, to sheet steel parts, and its subsequent fusion.

1.04 SUBMITTALS

A. Product Data:
   1. Submit catalog sheets, specifications, roughing dimensions and installation instructions for each item specified.

B. Samples:
   1. Submit one sample for each item of sanitary fittings and fixtures specified in the Contract Documents for approval. Samples will be returned and if approved, may be installed on the Project.

C. Quality Control Submittals:

1. Vitreous china sanitary appliances: Furnish relevant test certificates testifying that the vitreous china sanitary appliances supplied, comply with the provisions of ES 2645.

1.05 QUALITY ASSURANCE

A. Each fixture and fitting shall have plainly and permanently marked with the manufacturer's name or identification mark and the number of respective standard.

B. Vitreous china sanitary appliances shall pass the test requirements of ES 2645 for water absorption, crazing, chemical resistance, and resistance to staining and burning.

1.06 DELIVERY, STORAGE AND HANDLING

A. Complying with ES 1662 including the following:
   1. Handle sanitary appliances and associated components very carefully to avoid causing damage in any way.
   2. Leave wrappings and protection in place for as long as possible.
   3. Store under cover, protected from weather, dirt, damage, distortion and pilfering, and so that there is a convenient sequence of removal from the store to the work positions minimizing the risk of damage through double handling.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Sanitary fixtures shall comply with the minimum Standards as set out in this Section.

B. Sanitary fixtures shall be manufactured to standards acceptable for the intended purpose.

C. Fixtures and accessories shall always be obtained from one source as far as possible.

D. Sanitary appliances shall be supplied together with mounting and plugging devices, valves, chain, water plug, traps, handles, flexible pipes and accessories such as bolts, nuts, screws, hinges, fishers, etc., as required for the satisfactory installation.

E. All sanitary appliances unless specified otherwise shall be white, from an approved manufacturer, generally en-suite and complete with all necessary fittings.

F. Vitreous China: Comply with ES 2645 for;
   1. Requirements concerning the quality and dimensional tolerances for vitreous china appliances.
   2. The methods of testing by which their properties may be assessed.

G. Porcelain Enameled Cast Iron:
   1. Material shall show no cracks, chips, craze or discolorations.
   2. Enameled surfaces shall be acid resistant unless otherwise specified.

H. Waste Fittings: Comply with BS EN 274-1 for dimensional, performance, materials, and marking requirements for waste outlets, traps, and overflows which are not integral to sanitary appliances and connected to gravity drainage systems for;

1. Kitchen sinks.
2. Shower trays.
3. Wash basins.
4. Bidets.
5. Baths.

2.02 BATH-TUBS

A. Baths:
   1. Comply with ES 265 for baths made from porcelain enameled cast iron.
   2. Comply with BS 1390 for baths made from vitreous enameled sheet steel.
   3. Comply with ES 2663 for baths for domestic purposes made of acrylic material.

B. Connecting Dimensions:
   1. Comply with ES 2662 for domestic purposes made of acrylic material.
   2. Comply with ES 2598 for baths other than domestic purposes made of acrylic material.

2.03 SHOWER UNITS

A. Shower Trays:
   1. Comply with ES 2912 for prefabricated shower trays made from porcelain enameled cast iron.
   2. Comply with ES 2717 for prefabricated shower trays made from acrylic material.
   3. Comply with ES 2914 for prefabricated shower trays made from glazed ceramic.
   4. Comply with BS 6340-7 for Prefabricated Shower trays made from Vitreous Enameled Sheet Steel.

B. Shower Heads and Related Equipment:
   1. Comply with ES 2704.

C. Connecting Dimensions:
   1. Comply with ES 2601.

2.04 SINKS

A. Kitchen Sinks:
   1. Comply with ES 2650 for functional requirements and test methods.
   2. Comply with ES 2937 for connecting dimensions.

B. Fireclay Sinks:
   1. Comply with ES 1342 for dimensions and workmanship.

C. Sit-on and Inset Metal Sinks
   1. Comply with BS 1244-2 for Domestic Purposes.

D. Connecting Dimensions:
   1. Comply with ES 2937.

2.05 WASH BASINS

A. Fixtures:

1. Comply with ES 2652 for ceramic wash basins and pedestals.
2. Comply with ES 2587 for wash basins (one or three tap holes).

B. Connecting Dimensions:
1. Comply with ES 2592 for pedestal wash basins.
2. Comply with ES 2593 for wall-hang wash basins.

2.06 WATER CLOSETS

A. Water Closet Types:
1. Closed-coupled suites, one-piece or independent WC pans with integral trap manufactured from vitreous china or stainless steel and shall comply with ES 2672.
2. Wash down WC pans with horizontal outlet manufactured from vitreous china and shall comply with ES 2584.
3. WC Pans with Horizontal Outlet for use with 7.5 L Maximum Flush Capacity Cisterns manufactured from vitreous china and shall comply with ES 2585-3.

B. Operation:
1. Fixture shall flush satisfactorily without extraordinary rise of water level in the bowl.

C. Flushing Cisterns:
1. WC flushing cisterns with valve less siphons: comply with ES 2892 for the single type flush, 9L, or the dual flush type, either 4.5L or 9L.
2. Comply with ES 2590 for 7.5 L WC Flushing Cisterns.

D. Closet Seat:
1. Shall comply with ES 2649 for Plastics WC Seats.

E. Float Operated Valves:
1. Comply with ES 2579 for compact type float operated valves.

F. Connecting Dimensions:
1. Comply with ES 2586 for wall hang WC pan with close coupled cistern.
2. Comply with ES 2688 for wall hang WC pan with independent water supply.

G. Connectors:
1. Plastic connectors: comply with ES 2589 for use with horizontal outlet vitreous china WC pans.

2.07 URINALS

A. Fixture Types:
1. Comply with ES 2661 for stainless steel slab urinals.
2. Comply with ES 2588 for vitreous china bowl urinals (rimless type)

B. Flushing Cisterns:
1. Comply with ES 2648 for automatic flushing cisterns.

C. Operation:
1. Fixture shall flush satisfactorily without extraordinary rise in water level in the bowl.

2.08 VALVES

A. Comply with ES 2577 for diaphragm type float operated valves (copper alloy body) (excluding floats).

B. Comply with ES 2578 for diaphragm type float operated valves (plastic bodied) for cold water services only (excluding floats).

C. Comply with ES 2579 for compact type float operated valves for WC flushing cisterns (including floats).

2.09 BIDETS

A. Vitreous china bidets over rim supply only.
   1. Comply with ES 2904 for quality, workmanship and functional dimensions other than connecting dimension.
   2. Comply with ES 2595 for wall hang bidets with over-rim supply connecting dimensions.

PART 3 EXECUTION

3.01 PREPARATION

A. Ensure that any work necessary is or will be sufficiently complete and will not delay continuity of installation of sanitary appliances.

B. The sequencing of installation work shall be agreed with the Engineer.

C. Provide all necessary jointing compound, mortar, lead plugs and other accessary materials. Cut and pin, or plug and screw brackets, and make all necessary connections to water supply services, overflows, wastes and ventilating pipes.

D. Pipes to Appliances:
   1. Complying with ES 1662, install discharge pipes and water supply pipes before fixing the appliances. Make any union or detachable type joints between appliances, traps and pipes.

3.02 FIXTURE INSTALLATION

A. Install the Work of this section in accordance with the manufacturer's printed installation instructions and the following:
   1. Comply with the installation requirements stated in ES 1662;
      a. Where the sanitary appliances are subjected to frequent wet conditions, use copper alloy or stainless steel fixings and fastenings, unless the appliance manufacturer has supplied fixings and fastenings or has provided instructions about which fixings and fastenings are satisfactory.
      b. Any appliance shall not be embedded in the wall surface finish except where specified.
      c. Supply or discharge pipework shall not be used to support or fix the appliances.
      d. The appliances shall be fixed at the required position and height and shall be fixed plumb and level so that surfaces designed falls will drain as intended.

3.03 SEALANT APPLICATION

A. All appliances except, normally, cisterns, and the building structures shall be sealed as per the requirements stated in ES 1662.
   1. The correct specified sealant shall be used.
   2. The finishes to backgrounds shall be completed and the surface to receive the sealant shall be clean and dry.
   3. The minimum necessary of any protective coverings shall be removed to give access for the application of the sealant.
   4. Except specified otherwise, the sealant shall be applied in accordance with the manufacturer's instructions and leave a neat smooth surface and watertight joint.

3.04 FIELD QUALITY CONTROL

A. Sanitary appliances and fittings shall be free from damage and operated satisfactorily. Remedial measures shall be taken for any faults observed before handover.

B. All appliances shall drain speedily, quickly and completely through the installation.

3.05 CLEANING, FLUSHING AND ADJUSTMENT

A. Clean fixture and trim. Remove grease and dirt; polish surfaces but leave stickers and warning labels intact.

B. Flush supply piping and traps; clean strainers.

C. Adjust stops for proper delivery.

D. Adjust metering faucets for proper timing.

3.06 PROTECTION

A. Complying with ES 1662, the following protective measures shall be taken during or after installation of sanitary appliances;
   1. When using heat producing apparatus, ensure that adjacent building fabric is protected from scorch damage and risk of fire. Take particular care when working in roof spaces and other confined areas. Do not leave heat producing apparatus unattended or directed on to flammable materials.
   2. The pipework either before or after fixing shall not be damaged.
   3. All exposed pipe ends, branches and access points shall be covered with a purpose-made fitting or with a protective cover or cap to guard against entry of tools or building materials.
   4. Keep protective coverings in place as long as practically possible up to handover.
   5. Replace any appliances which are chipped, cracked, scratched, distorted or otherwise damage.
   6. Do not stand in or any on any appliance.
   7. Do not use appliances.

END OF SECTION

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

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SECTION 233400

HVAC Fans

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fans, motors, accessories, and hardware for general use.

1.02 REFERENCES

A. EBSC – 11: Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 2008 Handbook – HVAC Systems and Equipment.

C. BS 5720: Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings.

D. BS 5643: Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms.

1.03 DEFINITIONS

A. The terms in this Section shall comply with the terms and definitions stated in BS 5643 and EBSC – 11.

1.04 SYSTEM DESCRIPTION

A. Design and performance requirements:
   1. General requirements: Complying with the requirements of EBSC-11 the following shall be fulfilled:
      a. For fan systems which provide a constant air volume whenever the fans are running, the power required by the motor for the combined fan system at design conditions shall not exceed .47w per m^3/hr of supply air.
      b. For fan systems which are able to vary system air volume automatically as a function of load, the power required by the motor for the combined fan system at design conditions shall not exceed .74w per m^3/hr of supply air.

   2. Fan selection: Complying with the requirements of EBSC-11, the following shall be taken into consideration for the selection of fans:
      a. Fans shall be selected for stable performance based on normal temperature and, where applicable.
      b. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Selection should favor the more efficient fan types and ensure that the fans will be operating at peak efficiency.
      c. Motors driving fans shall have a minimum service factor of 1.15.
      d. Motors driving fans shall not be operating beyond their nameplate horsepower (kilowatts) as determined from measurement of actual current draw.
      e. Air volume.
      f. System resistance.

g. Entering air condition (moisture, industrial, air density).
h. Barometric pressure, altitude at installation location.
i. Type of application, industrial, residence, commercial.
j. Space available for installation.
k. Fan connection type and size.
l. Type of drive and arrangement, requirements of drive adjustment, type of bearing, drive guards, speed control, or stand by.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. Include product characteristics, performance criteria, and limitations.

B. Quality assurance submittals:
1. Instructions: Submit manufacturer's installation instructions.
2. Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials in accordance with manufacturer's written instructions and applicable referenced standards.

PART 2 PRODUCTS

2.01 GENERAL

A. The material and components of HVAC Fans shall Comply with the requirements of EBSC-11 and applicable Referenced Standards.
1. Capacity: Flow rate, static pressure, bhp, efficiency, revolutions per minute, power, size, sound power data and as indicated in the Contract Documents.
2. Fans: Statically and dynamically balanced, constructed in conformity with applicable Referenced Standards.
3. Factory primed before assembly in colour standard to manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Unless otherwise shown or specified, install the Work of this Section in accordance with the manufacturer’s printed installation instructions and/or applicable Referenced Standards including the following:
1. Fans shall be supported and restrained by noncombustible devices in accordance with the structural design requirements.
2. Motors and drives shall be easily accessible for operation, maintenance and repairs, and all rotating parts shall be guarded adequately.
3. Sufficient clearance and access shall be provided for inspection, cleaning and maintenance.
4. Air passage duct connection with the fan unit shall be through flexible duct.

5. The flexible duct materials shall be made of material classified as not easily ignitable and shall not exceed 250mm in length.

B. Noise control: In HVAC systems, controlling noise that can be generated from equipment and systems shall be implemented through the following guide lines:
   1. Choosing the operating condition of the fan so that it is at a high efficiency point on its characteristic; this minimizes fan noise.
   2. Ensuring good flow conditions for the air stream; the consequent benefits include components behaving more nearly as described in the manufacturer's data and reduced pressure losses, conserving energy and saving operating costs.
   3. Isolating vibrating components, including all machinery, ducts and pipe work from the structure.
   4. Installing flexible duct between equipment (air handler, fans) and duct connection.
   5. Choosing an in-duct silencer or other means to control airborne noise in ducts; a full silencer may not be required, as lining bends with acoustic absorbent may be adequate, but this depends on the results of noise predictions.
   6. Where fan noise will be a problem, sound attenuator should be used to meet the required sound level through attenuation.

3.02 FIELD QUALITY CONTROL

A. Fans should be checked for alignment, blade angles, rotational frequency, air flow rate, sound levels and operating pressures.

END OF SECTION

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SECTION 238100

DECENTRALIZED UNITARY HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section covers the requirements of room air conditioners including air conditioners of the self-contained or split system type.

1.02 REFERENCES

A. EBSC – 11: Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 2008 Handbook – HVAC Systems and Equipment.

C. BS 5720: Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings.

D. BS 5643: Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms.

1.03 DEFINITIONS

A. The terms in this Section shall comply with the terms and definitions stated in BS 5643 and the following:
   1. Room air-conditioner: Packaged equipment for air-conditioning the enclosure in which it is located.
   2. Room air-conditioner – Self-contained: A room air-conditioner in which the compressor and condenser are integral parts of the air handling unit.
   3. Room air-conditioner – Split: A room air-conditioner in which the compressor and condenser are separately mounted outside the air conditioned enclosure.

1.04 SYSTEM DESCRIPTION

A. Design requirements: Comply with the requirements of EBSC – 11.
   1. Equipment used in air-conditioning shall have minimum performance in accordance with the level of current technology.
   2. Cooling systems design loads for the purpose of sizing systems and equipment shall be determined in accordance with generally accepted engineering standards and handbooks using Heat Balance (HB) and Radiant Time Series (RTS) or equivalent methods given in EBSC – 11 in annex II.
   3. The normal design dry-bulb temperature for comfort air-conditioning can vary from 23^{o}C to 25^{o}C with the lower temperature applicable to zones with solar load and the higher value in all other zones.
   4. When a space has significant sensible equipment load, care should be taken for situations when the equipment is operating at part-load.
   5. The specification of indoor conditions shall take into considerations the anticipated mean radiant temperature and air movement.

6. The design outdoor air conditions shall be taken for dry-bulb and wet-bulb with a daily range calculated between maximum and minimum temperatures. The dry-bulb temperature value shall exceed more than 2.5% of the total hours during and the wet-bulb value is the average of the coincident wet-bulb temperature occurring at the design dry-bulb temperature. These temperatures are given in EBSC – 11 in annex I for some cities in Ethiopia.
7. The load contribution from the outdoor air introduced into a building for ventilation shall be calculated.
8. The load contribution from outdoor air infiltrating into a building shall be calculated by the procedures in EBSC – 11 in Annex II.

B. Performance requirements
1. Design air handling unit and supports to withstand all seismic loads. Refer to seismic loading criteria on the Contract Documents.
2. Seismic Performance: Design and install air handling units to assure that they remain in place with no separation of any parts and continued performance of their intended function when subjected to the specified seismic forces.
3. The design of the air handling units and supports shall be performed by a professional engineer experienced in the seismic design of air handling units.

1.05 SUBMITTALS

A. Product Data: Manufacturer's catalog sheets, brochures, performance charts, test data, standard schematic drawings, specifications and installation instructions for each type unit.

B. Quality Control Submittals:
1. Copy of Seismic Qualifications Certificate.

C. Contract Closeout Submittals:
1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Engineer's Representative.

1.06 QUALITY ASSURANCE

A. Comply with the requirements of EBSC-11 for testing and commissioning:
1. Testing and commissioning shall be carried out meticulously if a satisfactory installation is to be handed over to the Procuring Entity. It shall be ensured that these are carried out thoroughly and all results are properly documented.
2. All equipment and components supplied may be subjected to inspection and tests during manufacture, erection/installation and after completion. No tolerances at the time of inspection shall be allowed other than those specified or permitted in the relevant approved standards, unless otherwise stated. Approval at the time of inspection shall not be construed as acceptance unless the equipment proves satisfactory in service after erection.
3. Upon completion of installation of the system, the equipment of plants/systems are tested to check that they can function according to design & testing method equipment/system shall be in accordance with approved procedures.
4. Each manufacturer shall provide guarantee performance for the specified duty & conditions and, where necessary, test certificates.
5. All instruments shall be provided by the contractor or his commissioning agent, and evidence of the accuracy of the test instruments shall be provided wherever possible.

B. Seismic Qualification Certificate: Certificate from air handling unit manufacturer covering air handling units, accessories, supports, and components; and consisting of the following:
   1. Basis for Certification: Indicate whether Withstand Certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions, and loads transmitted to structure at each attachment point.
   3. Detailed description of equipment anchorage devices on which the certification is based including installation requirements.
   4. Comprehensive seismic engineering analysis of air handling units and supports.

PART 2 PRODUCTS

2.01 UNITARY AIR CONDITIONERS – GENERAL

A. Furnish equipment, accessories, control system and other necessary components as required by the Contract Documents. Comply with applicable Referenced Standards.

B. Provide air conditioning system flexible in buildings which employ an appropriate type setting.

C. Performance Rating: Cooling capacity of units shall meet the sensible heat and total heat requirements shown in the Contract Documents. In selecting unit size, make true allowance for "sensible to total heat ratio" to satisfy required sensible cooling capacity.

D. Machinery Guards: Provide guards as shown in the Contract Documents for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory fabricated casings.

E. Corrosion Prevention: Unless specified otherwise, equipment fabricated from ferrous metals that do not have a zinc coating or a duplex coating of zinc and paint shall be treated for prevention of rust with a factory coating or paint system complying with applicable Standards. For units located in high humidity areas, provide factory-coated coils for protection from corrosion by using multiple stage electro-deposition coating process.

2.02 ROOM-TYPE AIR CONDITIONERS

A. Units shall be window, through-the-wall or floor-mounted type as indicated. Capacity and electrical characteristics shall be as shown on Drawings.

B. Unless specified otherwise indicated in Contract Documents, perform the following:
   1. Provide units removable from inside the building for servicing without removing the outside cabinet.
   2. Construct outside cabinets, including metal grilles to protect condenser coils, of zinc-coated steel or aluminum.

3. Steel and zinc-coated surfaces shall receive at least one coat of primer and manufacturer's standard factory-applied finish Insulate cabinets to prevent condensation and run off of moisture.
4. Provide mounting hardware made of corrosion-resistant material or protected by a corrosion-resistant finish.
5. Provide air filters of the throw-away or permanent washable type removable without the use of tools and arranged to filter both room and ventilating air.
6. Remove condensate by means of a drain or by evaporation and diffusion.
7. Provide with metal or plastic mounting flanges on each side, top, and bottom of unit. For thru-the-wall installations provide aluminum or shop painted zinc-coated steel flanged telescopic wall sleeves.
8. Design wall sleeves to restrict driving rain. For window mounted units provide shop-painted metal mounting brackets, braces, and sill plates.
9. Mount compressors on vibration isolators.
10. Minimum cooling capacity shall be not less than that indicated.

C. Self-contained air conditioners: Unless specified otherwise indicated in Contract Documents, self-contained air conditioners shall be factory assembled and wired consisting of the following:
1. Cabinet.
2. Compressor.
3. Evaporator fan.
4. Integral, air-cooled or water-cooled condenser.
5. Steam, Hot-water, Electric-resistance or heating coil.
6. Air filters.
7. Controls.
8. Full charge of refrigerant and oil.

D. Split-system air conditioners: Split-system air conditioners shall be factory assembled and tested, floor-mounted, wall-mounted or ceiling mounted unit, with an air-cooled or water-cooled remote condensing unit, and field-installed refrigeration piping. Unit shall include a hot-water, steam, or electric-resistance heating coil.

PART 3 EXECUTION

3.01 INSTALLATION

A. Unless otherwise shown or specified, install the Work of this Section in accordance with the manufacturer’s printed installation instructions and/or applicable Referenced Standards.

B. Vibration control: Vibration shall be controlled by considering the following installation techniques unless specified otherwise:
1. Choose a good location for the plant, remote from sensitive areas. This also helps for noise control.
2. Ensure that vibration isolation is properly installed with no bridging material across the flexible mountings.
3. Ensure that vibration isolators are loaded to give equal deflections and installed to maintain vertical alignment of their springs and other components.
4. Isolators shall be aligned with the equipment as misaligned isolators are a source of many problems.

5. Check support bolts for integrity and free movement.
6. Do not neglect vibration from pipes and ducts.
7. Use flexible attachments to the structure.

3.02 FIELD QUALITY CONTROL

A. Testing and commissioning requirements:
   1. Shall comply with and follow the testing and commissioning procedures set out in EBSC – 11.

B. Air Conditioning System Pre-Start-Up and Start-Up:
   1. Upon completion of air conditioner installations, the Contractor shall visit the site, inspect the installations and notify the Engineer's Representative of any Work which must be done or modified prior to start-up.
   2. Upon completion of required Work, or modifications to installed Work and miscellaneous testing, all as required by the particular air conditioning system or apparatus, the Contractor shall supervise the conditioner start-up.
   3. Start-up the system and conduct a preliminary test, for the purpose of checking the general operation of the air conditioner, proving mechanical and electrical controls and making necessary adjustments.
   4. Provide pre-start-up check list, start-up list and operating instructions for air conditioner, framed under rigid plastic and place where directed in the applicable Room.

END OF SECTION

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DIVISION 26 – ELECTRICAL

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SECTION 260511

REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section shall apply to all Sections of Division 26.

B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, switchboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.

C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

D. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized as per EBSC-10 and ES. Aluminum conductors are prohibited.

E. Products specified in all sections of Division 26 shall comply with the applicable Referenced Standards listed in each Section.

F. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above Codes and Standards.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Code of Standard. Electrical Installation of Buildings.

B. IEC (International Electro-technical Commission (IEC) are the minimum requirements for materials and installation.

1.03 TEST STANDARDS

A. All materials and equipment shall be certified by Ethiopian Standards Agency (ESA) Standards where test standards have been established. Materials and equipment which are not covered by ES standards will be accepted, providing that materials and equipment are certified or otherwise determined to meet the safety requirements of other international certifying agency.

B. Definitions.
   1. Certified: Materials and equipment which:

a. Have been tested and found by ESA meet nationally/internationally recognized standards or to be safe for use in a specified manner.
b. Have record of certification.

2. Recognized Testing Laboratory: Testing laboratory which is recognized and approved by ESA.

1.04 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturer's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project.

1.05 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available.

B. When more than one unit of the same class or type of materials and equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:
1. Components of an assembled unit need not be products of the same manufacturer.
2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring and terminals shall be identified on the equipment being furnished and on all wiring diagrams.

1.06 VARIATIONS FROM CONTRACT REQUIREMENTS

A. Where the client, consultant or the Contractor requests variations from the contract requirements, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.07 MATERIALS AND EQUIPMENT PROTECTION

A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
2. During installation, equipment shall be protected against entry of foreign matter, and be cleaned both inside and outside before testing and operating.
3. Damaged equipment shall be repaired or replaced, as determined by the Engineer in Charge.
4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

5. Damaged paint on equipment shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.08 WORK PERFORMANCE

A. All electrical work shall comply with the requirements of EBSC, ES, IEC, and ISO in addition to other references required by contract. and other references.

B. Job site safety and worker safety is the responsibility of the Contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized.

D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. Refer to Article OPERATIONS AND STORAGE AREAS under Section 010000, GENERAL REQUIREMENTS.

E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 010000, GENERAL REQUIREMENTS.

F. Coordinate location of equipment and conduit with other trades to minimize interference.

1.09 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working clearances shall not be less than specified in the EBSC.

C. Inaccessible Equipment:
   1. Where the client determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost.
   2. "Readily accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system, and obtain electric utility company approval for sizes and settings of these devices.

1.10 EQUIPMENT IDENTIFICATION

A. Install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, control devices and other significant equipment.

1.11 SUBMITTALS

A. Submit to the Engineer's Representative SHOP DRAWINGS (if practical), PRODUCT DATA, and/or SAMPLES.

B. Engineer's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.

C. All submittals shall include copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the consultant to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.

E. The submittals shall include the following:
   1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, manuals, pictures, nameplate data, and test reports as required.
   2. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
   3. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.

F. Maintenance and Operation Manuals:
   1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
   2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the local representatives for the material or equipment.
   3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
   4. The manuals shall include:
      a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
      b. A control sequence describing start-up, operation, and shutdown.
      c. Description of the function of each principal item of equipment.
      d. Installation instructions.
      e. Safety precautions for operation and maintenance.
      f. Diagrams and illustrations.
      g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
      h. Performance data.

i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization as applicable.

G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

H. After approval and prior to installation, submit to the Engineer in charge with one sample of each of the following:
1. A minimum 300 mm length of each type and size of wire and cable .The length of the sample shall be sufficient to show all markings provided by the manufacturer.
2. Each type of conduit and trunkings.
3. Conduit clamps.
4. Each type of outlet box, switch, socket outlet and MCB.

1.12 SINGULAR NUMBER

A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.13 ACCEPTANCE CHECKS AND TESTS

A. The Contractor shall furnish the instruments, materials, and labor for tests.

B. The Contractor shall coordinate the installation, testing, and adjustment of all components between various manufacturer’s representatives and technicians so that a complete, functional, and operational system is delivered.

C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests. Repair, replacement, and retesting shall be accomplished at no additional cost.

1.14 WARRANTY

A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation.

1.15 INSTRUCTION

A. Instruction to designated personnel shall be provided for the particular equipment or system as required in each associated technical specification section.

B. Furnish the services of competent instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation, and shall be trained in operating theory as well as practical operation and maintenance procedures.

C. A training schedule shall be developed and submitted by the Contractor and approved by the Engineer prior to the planned training.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for Electrical Installations: Section 260511.

B. Grounding and Bonding for Electrical Systems: Section 260526.

C. Raceway and Boxes for Electrical Systems: Section 260533.

D. Earthwork: Section 310000.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Code of Standard. Electrical Installation of Buildings.

B. ES 1483: Specification for 600/1000V and 1900/3300V Armoured Electric Cables.

C. ES 1537: ….Electric Cable PVC Insulated Non-Armoured Cables for 450/750V for Electric Power, Lighting and Internal Wiring.

D. ES 1563: ….Specification for 600/1000V and 1900/3300V Armoured Electric Cables having PVC Insulation.

E. ES IEC 60227: PVC Insulated Cables Rated Voltage 450/750V.

F. IEC 60502: Power Cables with Extruded Insulation and their Accessories for Rated Voltages of 1KV and 3KV.

G. IEC 60332: Tests on Electric and Optical Fiber Cables under Fire Conditions.

H. IEC 61034: Measurement of Smoke Density of Cables Burning Under Defined Conditions.

I. IEC 61238-1: ……. Compression and Mechanical Connectors for Power Cables for Rated Voltages up to 30KV.

1.03 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 1000V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical

Installations.

1. Product catalogue and samples:
   a. Submit product catalogue and samples (30cm each) of the low voltage power conductors and cables.

2. Certifications: submit the following:
   a. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested

1.05 QUALITY ASSURANCE

A. Refer to Paragraph, Qualifications (Products and Services), in Section 260511, Requirements for Electrical Installations.

B. Factory tests:
   3. Conductors and cables shall be thoroughly tested at the factory per ES to ensure that there are no electrical defects. Factory tests shall be certified.

PART 2 PRODUCTS

2.01 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with ES, IEC, as specified herein, and as shown on the drawings.

B. All conductors shall be copper.

C. Size of conductor: The minimum nominal cross-sectional area of conductor shall be:
   1. $1.5mm^2$ for cables and insulated copper conductors for power and lighting circuits. $1mm^2$ Shall be the minimum nominal cross sectional area for bell call systems.
   2. 10.0mm2 for bare copper conductors for power circuits.
   3. 0.5mm2 for flexible cables of copper conductors for extra low voltage.

D. Type of conductors and cables to be used:
   1. Conductors for fixed installation, PVC insulated, non-sheathed 450/750V rated to IEC 60227-3.
   2. Cables for indoor fixed installation, PVC insulated, with PVC inner sheath and PVC outer sheath rated 450/750V to IEC 60227-4.
   3. Cables for indoor and outdoor fixed installation PVC insulated, with PVC inner sheath or XLPE insulated, both with h PVC outer sheath rated 0.6/1KV to IEC 60502-1 and shall be armoured if exposed to mechanical damage.
   4. Flexible cable shall be used for connection to equipment.
   5. Where requirement specifies for fire rated cables , shall be flame retardant complying with IEC 60332-1 , shall be fire retardant complying with IEC 60332-3 and shall be halogen free with low smoke emission complying with IEC 61034-2 , low toxicity complying with IEC 60754-1 and low corrossivity complying with IEC-60754-2.

E. Color identification of conductors:
   1. Cores of non-flexible cable for fixed wiring:
      a. AC Single Phase or Three Phase Circuit

1) Protective (including earthling) conductor: Green and Yellow.
2) Phase: Red or Yellow or Blue.
3) Neutral: Black.

b. Wire derived from 3 wire DC Circuit:
1) Positive : Red
2) Middle Wire: Black.
3) Negative: Blue.

2. Cores of flexible wiring for connection to equipment with relative motion as specified in EBSC-10:2015:
a. Single core:
1) Phase: Brown.
2) Neutral: Blue.
3) Protective: Green and Yellow.

b. 2 core:
1) Phase: Brown.
2) Neutral: Blue.

c. 3 core:
1) Phase: Brown.
2) Neutral: Blue.
3) Protective: Green and Yellow.

d. 4 & 5 core:
1) Phase: Brown/ Black.
2) Neutral: Blue.
3) Protective: Green and Yellow.

2.02 CONNECTORS AND TERMINATIONS

A. High conductivity compression and mechanical connectors complying with IEC 61238-1 shall be used.

B. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be brass, bronze or zinc-plated steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Install conductors in accordance with EBSC-10:2015, ES, as specified, and as shown on the drawings.
2. Non-sheathed cables for fixed wiring shall not be installed unless enclosed in conduits, ducting or trunking, however, this provision does not apply to a protective conductor.
3. Splice conductors only in outlet boxes, junction boxes pullboxes or switchboards.
4. Install cable supports for all vertical and horizontal feeders in accordance with EBSC-10:2015 Table 8.3.

5. In panel-boards, cabinets, wire-ways, switches, enclosures, and equipment assemblies tie the conductors with non-metallic ties.
6. Conductor and Cable Pulling:
   a. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling.
   b. All conductors in a single conduit shall be pulled simultaneously.
   c. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

7. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

B. Installation in manholes:
1. Bend the cables as required around the manhole walls, but not to a radius less than specified in EBSC-10:2015 Table 8.2.

C. Jointing and termination installation:
1. Joints and terminations shall be mechanically and electrically secure, and tightened.
2. Ferrules, compression connectors and bare portions of cable core resulting from a jointing or terminating process shall be insulated with an approved type of insulating tape or heat shrinkable tubing after completion of process. Such insulating tape or heat shrinkable tubing shall have equal or better electrical and mechanical properties as those of the original insulation removed, and shall be adhered to the cores securely and permanently. The final thickness shall be in a smooth contour throughout the whole length.

3.02 IDENTIFICATION AT JOINT OR TERMINATION

A. At each joint or termination, a non-ferrous metallic label shall be fixed to the cable giving the size and identification of the cable.

3.03 EXISTING CONDUCTORS

A. Unless specifically indicated on the plans, existing conductors shall not be reused.

3.04 DIRECT BURIAL CABLE INSTALLATION

A. Direct buried conductors, cables, or raceways shall be installed to meet the minimum cover requirements shown in EBSC-10:2015 Table 8.1.

B. Work with extreme care near existing ducts, conduits, cables, and other utilities to prevent any damage.

C. Excavation and backfill is specified in Section 310000, Earthwork. In addition:
1. Place a minimum of 75 mm bedding sand in the trenches before installing the cables.
2. Place a minimum of 75 mm shading sand over the installed cables.
3. Install continuous approved type cable cover tiles above the cables before backfilling.

D. Install the cables in continuous lengths. Connection within cable runs shall not be accepted.

E. Warning tape shall be continuously placed 300 mm above the buried cables.

3.05 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
   1. Visual Inspection and Tests: Inspect physical condition:
   2. Electrical tests:
      a. After installation but before connection to utilization devices, carry out continuity and insulation test of the conductors. The values of the tests should be according to Appendix 1 (Inspection and Testing) of EBSC-10:2015. Carry out insulation test with an insulation resistance tester. Existing conductors to be reused shall also be tested.

END OF SECTION

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SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for Electrical Installations: Section 260511.

B. Low-Voltage Electrical Power Conductors and Cables: Section 260519.

C. Raceway and Boxes for Electrical Systems: Section 260533.

D. Facility Lightning Protection: Section 264100.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Code of Standard. Electrical Installation of Buildings.

B. ES 1332: Electrical Earthing Clamps for Earthing and Bonding , Specification.

C. IEC 60364. Electrical Installation of Buildings.

D. ES IEC 60423: Conduit System for Cable Management.

E. IEC 61238-1: Compression and Mechanical Connectors for Power Cables for Rated Voltages up to 30KV.

F. ES IEC 62305 -1 : Protection Against Lightning , PART1 , General Principles.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical Installations.
   1. Product catalogue:
      a. Submit the product catalogues of the products for the Grounding and Bonding Works.

   2. Shop Drawings:
      a. Submit sufficient information to demonstrate compliance with drawings and specifications.
      b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.

B. Test Reports:
   a. Prior to the final inspection, submit ground resistance field test reports to the Engineer in Charge.

1.04 QUALITY ASSURANCE

A. Refer to Paragraph, Qualifications (Products and Services), in Section 260511, Requirements for Electrical Installations.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING CONDUCTORS

A. No automatic cutout or switch shall be placed in the earthling or bonding conductor of a wiring system unless the opening of the cutout or switch disconnects all sources of energy.

B. System earthling conductors whether also used for earthling electrical equipment or not, may be insulated or bare, and shall be of copper. Insulation color shall be Green and Yellow.

C. Bonding conductors whether also used for earthling electrical equipment or not , may be insulated or bare and shall be:
   1. A conductor of copper or other corrosion-resistant material, insulated or bare.
   2. A bus bar or steel pipe.
   3. Rigid metal conduit except where material having a deteriorating effect may come in to contact with the metal or in any exposed raceway installed is exposed to mechanical damage , in which case a separate conductor as required in (a) shall be installed within the conduit.
   4. Electrical metallic tubing except as described in (c) above in which case a separate conductor as required in (a) shall be installed.
   5. Other metal raceways or cable armour.

D. Conductor sizes shall not be less than shown on the drawings, or not less than required by EBSC-10:2015, whichever is greater.

2.02 GROUND RODS

A. Ground rods shall be not less than 16.0mm in diameter if of iron or steel, or 12.7mm if non-ferrous metal or ferrous metal clad with a non-ferrous metal. Stainless steel ground rods shall be used for corrosive soil conditions.

B. Quantity of rods shall be as shown on the drawings, and as required to obtain the specified ground resistance.

2.03 PLATE ELECTRODE

A. Plate Electrodes shall present not less than 0.2m2 of surface to exterior soil and be not less than 6.35mm in thickness if of iron or steel, or 1.5mm if of ferrous metal.

2.04 GROUND CONNECTIONS

A. Earthling Conductor connection to electrode.
   1. Earthling Conductor connection to electrode shall be:
      a. A bolted clamp.

b. Pipe fitting plug or other device, screwed into the pipe or into the fitting.
c. Copper welding by the thermit process, brazing, or silver solder. Or
d. Other equally substantial means.

2. Where a bolted clamp is used for a wet location or for direct earth burial, the clamp shall be of copper, bronze, or brass and the bolts shall be of similar material or of stainless steel.
3. Connections that depend on solder shall not be used, except for connections utilizing silver solder.

B. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.

C. Above Grade:
1. Bonding Jumpers: Approved for use with copper conductors.Use compression or mechanical type connectors. Connectors or lugs shall use zinc plated steel bolts, nuts, and washers.
2. Connection to Grounding Bus Bars: Approved for use with copper conductors. Use mechanical or compression type lugs, with brass or bronze bolts, nuts, and washers.
3. Connection to Equipment Rack and Cabinet Ground Bars: Approved for use with copper conductors. Use compression or mechanical type lugs, with zinc-plated steel bolts, nuts, and washers.

PART 3 EXECUTION

3.01 GENERAL

A. Install grounding equipment as shown on the drawings, Bill of Quantities and as specified herein.

B. Equipment Grounding: Metallic piping, electrical enclosures, metallic raceways, metallic junction boxes, metallic outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.02 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.03 INSTALLATION OF EARTHLING CONDUCTOR FOR A SYSTEM

A. The earthling conductor for a system shall be without joint or splice throughout its length, except in the case of bus bars, thermit-welded joints, compression connecters applied with a compression tool compatible with the particular connector, or devices acceptable far connection in series with the earthling conductor.

B. $16mm^2$ or larger copper earthling conductor which is free from exposure to mechanical injury may be run along the surface of the building construction without metal covering or protection, if it is rigidly stapled to the construction; otherwise, it shall be in conduit, electrical metallic tubing or cable armour.

C. Magnetic materials used to enclose grounding conductors shall be bonded to the

grounding conductor at both ends.

D. Where a earthling conductor is run in the same raceway with other conductors of the system to which it is connected, it shall be insulated, except that where the length of the raceway does not exceed 15 m between pull points and does not contain more than the equivalent of two quarter bends between pull points, an un-insulated earthling conductor shall be permitted to be used.

3.04 EARTHING CONDUCTOR CONNECTION TO ELECTRODE

A. Execute using the materials specified on materials section. Make connections tight.

B. Not more than one conductor shall be connected to the earthling electrode by a single clamp or fitting, unless the clamp or fitting is specifically designed for multiple conductor connection.

3.05 ELECTRODES

A. Electrodes shall have a clean metal surface which is not covered with paint, enamel, or other poor conducting material.

B. Rod electrodes shall be spaced not less than 3m apart (if more than two rods are required).

C. Laying of Electrodes:
   1. Electrodes shall be buried at least 250mm below permanent moisture level as far as practical.
   2. In a horizontal trench where rock bottom is encountered at depth less than 1.2m.

D. Spacing and interconnection:
   1. Where multiple grounding electrodes exist at a building, including those used for signal circuits, radio, lightning protection, communication, community antenna distribution systems or any other purpose, they shall be:
      a. Separated by at least 2 m from each other.
      b. Bonded together with not less than 16mm2 copper conductor protected by location from mechanical injury. And
      c. In the case of lightning protection systems, bonded together in accordance with Item (b) at or below ground level.

E. Where any or all of the separate earthling electrodes are bonded together the bonding, conductor shall be:
   1. Installed so as not to be subjected to mechanical damage. And
   2. Connected to electrodes for power systems by means of a bolted clamp or soldered joints and preferably be connected to other electrodes in the same manner.

3.06 DISTRIBUTION BOARDS, MOTOR CONTROL CENTERS, ENGINE-GENERATORS, AUTOMATIC TRANSFER SWITCHES, AND OTHER ELECTRICAL EQUIPMENT

A. Connect the equipment grounding conductors to the ground bus.

B. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

3.07 RACEWAY

A. Conduit Systems:
   1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
   2. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with equipment grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders, and power and lighting branch circuits.

C. Boxes, Cabinets, Enclosures, and Panel boards:
   1. Bond the equipment grounding conductor to each metallic pull box, metallic junction box, metallic outlet box, metallic device box, cabinets, and other metallic enclosures through which the conductor passes.
   2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

D. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle ground terminal to a jumper to the branch circuit equipment grounding conductor.

E. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green and yellow ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

F. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.08 LIGHTNING PROTECTION SYSTEM

A. Bond the lightning protection system to the electrical grounding electrode system with not less than 16mm2 copper conductor.

3.09 MAIN ELECTRICAL ROOM GROUNDING

A. Provide ground bus bar and mounting hardware at main electrical room as shown on the drawings and bill of quantities.

3.10 GROUND RESISTANCE

A. Each earth electrode shall have a resistance (in ohm) not exceeding the product given by 10 times in the number of earth electrodes to be provided.

B. The whole of the earth termination network shall have a combined resistance to earth without taking account of any bonding to other services.

C. Make any modifications or additions to the grounding electrode system necessary for

compliance. Final tests shall ensure that this requirement is met.

3.11 ACCEPTANCE CHECKS AND TESTS

A. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.

B. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Below-grade connections shall be visually inspected by the Engineer in Charge prior to backfilling. The Contractor shall notify the Engineer in Charge before the connections are ready for inspection.

END OF SECTION

SECTION 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Joint Sealants: Section 079200.

B. Construction Painting: Section 099101.

C. Requirements for Electrical Installations: Section 260511.

D. Low-Voltage Electrical Power Conductors and Cables: Section 260519.

E. Grounding and Bonding for Electrical Systems: Section 260526.

F. Earthwork: Section 310000.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Code of Standard. Electrical Installation of Buildings.

B. ES 1440 : 2005: Cable Trunking. Steel Surface Trunking.

C. ES IEC 61386: 2006: Conduit Systems (Rigid , Pliable and Flexible).

D. ES IEC 60423 -2006: Conduit System for Cable Management.

E. IEC 60364. Electrical Installation of Buildings.

F. IEC 61537-2006: Cable Management - Cable Tray Systems and Cable Ladder Systems.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical Installations.
   1. Product data:
      a. Manufacturer's Literature and Data for conduits, trunkings and boxes to be used in the project.

B. Certification:
   1. Prior to the final inspection, submit the following certifications to the Engineer.
      a. Certification by the contractor that the material has been properly installed.

1.04 QUALITY ASSURANCE

A. Refer to Paragraph, Qualifications in Section 260511: Requirement for Electrical Installations.

PART 2 PRODUCTS

2.01 MATERIAL

A. Conduit Size: According to the drawings but not less than 13mm unless otherwise shown.

B. Conduit:
1. PVC conduit and accessories:
a. Rigid conduit and conduit fittings:
1) Rigid plain PVC conduits shall comply with IEC 61386-21 and shall have clasification as below:
a) According to mechanical properties - for heavy mechanical stress.
b) According to temperature - with a permanent application temperature range of -5^0C to 6^0C.

2) Rigid plain PVC conduit fittings:
a) Shall comply with IEC 60423.
b) Temperature range of - 5^0C to 6^0C.

b. Pliable Conduit:
1) Pliable conduits shall be formed of self-extinguishing plastic materials.
2) Shall comply with IEC 61386-22.
3) Pliable conduit fittings shall comply with IEC 60423.
4) Conduits shall be suitable for installation, storage or transport at temperature range of -5°C to +60^0C.

c. PVC Boxes:
1) PVC boxes for enclosure of electrical accessories shall be of heavy duty having dimensions complying with IEC 60670.
2) They shall be interchangeable with the steel boxes complying with the same IEC standard. The minimum wall thickness of boxes shall be 2 mm.

d. PVC Couplers:
1) Plain, molded slip-type couplers and expansion type couplers to IEC 61035-1 shall be used in the jointing of conduits.
2) Adhesive/jointing cement for jointing shall be the type recommended by the manufacturer.

2. Steel conduit and accessories:
a. Steel conduits:
1) Steel conduits, except flexible conduits, shall be of heavy gauge, screwed, and longitudinally welded.
2) Shall be hot-dip zinc coated both inside and outside against corrosion.
3) Shall comply with IEC 61386-21.

b. Steel Flexible Conduit:
1) Steel flexible conduits and solid type brass adaptors shall comply with IEC 60386-23.
2) In addition, the steel conduits shall be of the metallic water tight pattern

and PVC over-sheathed.

3) The flexible conduit adaptor shall comprise two parts, an inner core and an outer ferrule. The inner core screws into the bore of the conduit together with an outer ferrule which caps off the end of the conduit, so that the adaptor can provide an extremely strong joint. The core shall lock against the outer ferrule and isolate any sharp cut edges in the conduit.

c. Steel Conduit Fitting:
   1) All Steel Conduit Fittings shall be hot-dip zinc coated or sherardized both inside and outside against corrosion and shall be tested to comply IEC 60386-21.
   2) Adaptable boxes complete with covers shall be of cast iron or galvanized steel. Boxes of the preferred sizes as given in IEC 60670 shall be used.
   3) Circular boxes, dome covers and hook covers shall be of galvanized malleable cast iron.
   4) Ceiling mounted boxes shall be of deep pattern type having an internal depth of not less than 60 mm.
   5) Bushes and tube ends shall be of brass.
   6) Distance (spacing) saddles shall be of galvanized cast iron.
   7) The screws or tightening and fixing the saddles shall be of brass.

d. Metal boxes for electrical accessories:
   1) Metal Boxes for Electrical accessories shall have heavy protection both inside and outside in accordance with IEC 60670.
   2) Metal boxes complete with covers for enclosure of electrical accessories in conduit installation shall comply with IEC 60670.
   3) Boxes used to house accessories such as domestic switches, socket outlets, spur units, etc. shall have a depth suitable for the accessories to be housed.

e. Screw:
   1) Screws used for fixing boxes and spacing saddle, and for tightening covers and spacing saddles shall have ISO metric threads.
   2) They shall be of brass or steel and if of steel they shall be protected against corrosion by zinc coating.

3. PVC trunking and accessories:
   a. PVC trunking and fittings shall comply with IEC 61084-1.

4. Steel trunking and accessories:
   a. Steel trunking:
      1) Steel surface trunking shall be of square or rectangular cross section. One side of the trunking shall be removable or hinged.
      2) No projection from screw or other sharp object will be allowed inside the trunking.
      3) Steel underfloor (duct) trunking shall be so designed and constructed as to permit the laying of the trunking on a structural floor without ingress of water or cement whilst the floor is screeded.
      4) Steel surface and Steel Underfloor trunking and fittings shall be compatible to the requirements laid down in IEC 61084-1.
      5) Manufacturer's standard fittings such as tee or angle pieces, connectors, etc. shall be used throughout.

6) Steel surface trunking and steel underfloor (duct) trunking and associated fittings shall have hot-dip zinc coating for protection against corrosion.

b. Steel Surface Trunking Cover:
   1) Trunking and fittings shall have removable or hinged covers extending over the entire length.
   2) The covers shall be of the same material and finish as those of the trunking body.
   3) Removable covers shall be held in position on the trunking either by the natural elasticity of the material of the cover (e.g. spring capped trunking) or by other approved means which hold the covers tightly onto the trunking body and cause no damage to the cables inside.
   4) Bends, tee junctions, etc. shall also be fitted with removable or hinged covers of the same construction as that of the trunking.

c. Screw:
   1) Screws used for securing a cover or connector and for fixing a trunking shall have ISO metric threads.
   2) They shall be of brass or steel. Steel screws shall be protected against corrosion by zinc coating.
   3) Electro-brass plated screws or self-tapping screws shall NOT be used.
   4) Projection of screws inside a trunking or a trunking fitting will not be allowed.

5. Metallic Cable Trays and Ladders:
   a. Metallic Cable Trays:
      1) Shall comply with IEC 61537.
      2) Shall be fabricated from perforated hot dip galvanized sheet steel.
      3) Shall have bends, tee pieces, adapters and other accessories from same manufacturer.
      4) For heavily corrosive environments where specified in the Contract, Specification or on the Drawings, cable ladder fittings and accessories shall be manufactured from stainless steel.

   b. Cable ladders:
      1) Shall comply with IEC 61537.
      2) Shall be manufactured from hot rolled steel to BS 1449: Part 1 and then hot dipped galvanized.
      3) Shall be of "heavy duty" type.
      4) Shall have bends, equal tees cross overs, internal/external risers, reducers, couplers from same manufacturer.
      5) For heavily corrosive environments where specified in the Contract, Specification or on the Drawings, cable ladder fittings and accessories shall be manufactured from stainless steel.

PART 3 EXECUTION

3.01 PENETRATIONS

A. Cutting of holes:
   1. Cut holes in advance where they should be placed in the structural elements, such as

ribs or beams. Obtain the approval of the Resident Engineer prior to drilling through structural elements.

B. Fire-stop: Where conduits, wire-ways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight.

3.02 INSTALLATION, GENERAL

A. Carry out installation works in accordance with ES , IEC standards , as per drawings and Bill of Quantities.

B. Install conduit as follows:
1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut square, ream, remove burrs, and draw up tight.
6. Support conduits independently. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.
7. Support within 300 mm of changes of direction, and within 300 mm of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps until wires are pulled in, to prevent entry of debris.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid conduit installations, provide a locknut on the inside of cabinets, junction boxes, pull boxes and outlet boxes.

3.03 CONCEALED WORK INSTALLATION

A. In Chase and Concrete:
1. Chase in wall shall be made neatly and of ample dimension to allow the conduit be fixed in the desired manner.
2. Conduit in chase shall be fixed by means of saddles or other approved means of fixing.
3. Conduits in concrete shall be laid in position and firmly fixed to reinforcement bars by steel binding wires before the concreting is done.
4. Make couplings and connections watertight.

B. Above Suspended Ceilings and in Walls:
1. Mixing different types of conduits indiscriminately in the same system is prohibited.
2. Align and run conduit parallel or perpendicular to the building lines.

3.04 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Mixing different types of conduits indiscriminately in the system is prohibited.

C. Align and run conduit parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs as per EBSC-10.

3.05 DIRECT BURIAL INSTALLATION

A. Refer to Section 260541, Underground Electrical Construction.

3.06 HAZARDOUS LOCATIONS

A. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.

B. Install approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the ESBC-10.

3.07 WET OR DAMP LOCATIONS

A. Unless otherwise shown, use conduits of rigid steel.

B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.

3.08 MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.

B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water. Provide a green and yellow equipment grounding conductor with flexible metal conduit.

3.09 EXPANSION JOINTS

A. Provide expansion and deflection couplings for conduits that are secured to the building structure on opposite sides of a building expansion joint.

3.10 CONDUIT SUPPORTS, INSTALLATION

A. Use pipe straps or individual conduit hangers for supporting individual conduits.

B. Support multiple conduit runs with trapeze hangers. Attach each conduit with U-bolts or other approved fasteners.

C. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

3.11 BOX INSTALLATION

A. Boxes for Concealed Conduits:
   1. Flush-mounted.
   2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

3.12 INSTALLATION OF CABLE TRAYS

A. Connection between Adjacent Lengths of Tray Connections between adjacent lengths of tray, tee or bend pieces, shall be made by butt joints and fixed by mushroom-head steel roofing bolts and nuts .The connection shall be mechanically strong so that no relative movement between the two lengths can occur.

B. Cable trays shall be cut along a line of plain metal only, i.e. they shall not be cut through the perforation. All cut edges of the galvanized cable tray shall be prepared and treated with a cold galvanized paint.

C. Holes cut in a cable tray for the passage of cable shall be provided with grommets. Alternatively, they shall be bushed or lined.

D. Cable trays shall be fixed securely to the walls, ceiling or other structure by means of mild steel hangers or brackets of adequate mechanical strength. The hangers or brackets shall be painted with anti-rust epoxy paint unless otherwise specified.

E. Fixings for cable trays shall be disposed at regular intervals not exceeding 1.2m for straight run and at a distance not exceeding 225mm on both sides from a bend or intersection.

F. A minimum clear space of 20mm shall be left behind all cable trays.

G. Single-core cables shall be secured to the cable tray by clamps made of non-ferrous materials specially designed to suit the dimension of the cables. The clamp shall be secured to the cable tray by means of bolts, washers and nuts.

H. Cable saddles or cable clamps shall be provided along the entire cable route with their spacing in accordance with the manufacturer’s recommendation.

3.13 INSTALLATION OF CABLE LADDER

A. Dropout plate of width same as the cable ladder shall be provided to support the cables locally as they exit a ladder down between the rungs.

B. The cable ladders shall be jointed by flexible (expansion) couplers across the expansion joints of the building structure.

C. Rigid fitting across the expansion joints shall not be allowed.

D. Unless otherwise specified, proprietary ladder covers (ventilated or closed as specified) shall be fixed onto the cable ladder following the installation details recommended by the manufacturer.

E. The end of a run of cable ladder shall be fixed to the wall or slab with proprietary end connectors. If it is far from the wall or slab, a proprietary "stop end" connector shall be fixed to the end of a cable ladder run in order to give a neater appearance. Installation details shall follow the manufacturer's recommendation.

F. The cable ladders shall be bonded and earthed throughout. Across all joints of the cable ladder, copper connectors shall be fixed onto the cable ladder in order to maintain the earth continuity. Factory-made attachment points shall be provided near the joints for fixing the earth continuity connectors.

G. The inside radius of all bends of the cable ladder system shall not be less than 300mm.

H. Supports shall be properly spaced at distance not exceeding 1500mm for straight run to satisfactorily support the weight of the ladder and cables. They shall also be provided at a distance not exceeding 300mm on every side from a bend or intersection.

END OF SECTION

SECTION 262413

SWITCHBOARDS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for Electrical Installations: Section 260511.

B. Low-Voltage Electrical Power Conductors and Cables: Section 260519.

C. Grounding and Bonding for Electrical Systems: Section 260526.

D. Raceway and Boxes for Electrical Systems: Section 260533.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Code of Standard. Electrical Installation of Buildings.

B. IEC 60364: Electrical Installation for Buildings.

C. IEC 60439: Low Voltage Switchgear and Assemblies.

D. IEC 60529: Degree of Protection Provided by Enlosures.

E. IEC 60947: Low voltage swithcgear and controlgear.

F. IEC 60755: General Requirements for Residual Current Operated Protection Devices.

G. IEC 62040: Un-interruptable Power Supplies (UPS).

H. IEC 60664 -1 / 61326: Power Factor Controller.

I. IEC 60051: Measuring Instruments.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical Installations.

B. Shop Drawings:
   1. Submit sufficient information to demonstrate compliance with Drawings and Bill of quantities.

C. Product Data: Prior to assembly of switchboards, submit the following data for approval:
   1. Complete electrical ratings.
   2. Circuit breaker sizes.
   3. Technical data for each component.

1.04 QUALITY ASSURANCE

A. Switchboards shall be thoroughly tested to assure that there are no electrical or mechanical defects.

B. The following additional tests shall be performed:
   1. Verify that circuit breaker sizes and types correspond to drawings.
   2. Verify tightness of bolted electrical connections.
   3. Exercise all active components.
   4. Perform an insulation-resistance test.

PART 2 PRODUCTS

2.01 ENCLOSURES AND COMPONENTS

A. Self-contained floor mounted cubicle:
   1. Shall comply to IEC 60439.
   2. The framework of the switchboard shall be fabricated from rolled steel sections of thickness not less than 2.5 mm and shall be self-supporting when assembled uniform in height and depth from front to back. The rigid construction shall be designed to withstand without any sag, deformation or warping, the loads likely to be experienced during normal operating, maintenance or maximum fault condition.
   3. The front shall be provided with covers/doors of box formation. The switchboard shall be dust and vermin proof. All covers and doors shall be provided with grommets and dust seals to exclude dust and dirt. Louvers or ventilation vent with filter shall be provided at the sides and back for adequate ventilation.
   4. The switchboards shall be of Form 2b separation where the bus bar separation from the switchgears and the incoming and outgoing terminals is achieved by metallic or non-metallic rigid barriers or partitions.
   5. Withdraw able type of switchgears shall be mounted on the framework assembly, including the runner rails and fixed rear isolation contacts, which shall be supplied as a part of the switchgear assembly. Each withdraw able switchgear shall be housed in its own compartment with rear connected bus bars.
   6. The switchboard shall undergo de-rusting treatment, anti-rust treatment and be finished with epoxy dry-powder and oven baked semi-gloss enamel grey.

B. Pedestal floor mounted switchboards:
   1. Shall comply to IEC 60439.
   2. The framework of the switchboard shall be fabricated from sheet steel of thickness not less than 2.5 mm. The switchboard shall be self- supporting when assembled. The switchboard shall be of rigid construction and shall be designed to withstand without any sag, deformation or warping, the loads likely to be experienced during normal operating, maintenance or maximum fault conditions. All panels shall be fabricated from sheet steel of thickness not less than 2. 0 mm.
   3. Removable covers shall be provided at the front to give access to all parts for maintenance and easy removal if necessary. An inspection chamber of suitable dimension shall be provided in between the bus bar chamber and the main incoming switchgear for testing, inspection and accommodating current transformers for the power correction equipment and other monitoring and indicating equipment that may be installed at a later stage.

4. The switchboard shall undergo de-rusting treatment, anti-rust treatment and finished with epoxy dry-powder and oven baked semi-gloss enamel grey.

C. Wall mounted switchboards:
   1. Shall comply to IEC 60439.
   2. The switchboard shall be fabricated from sheet steel of thickness not less than 2.0 mm. The enclosure shall be of all welded construction with sheets bent where possible so as to minimize the number of welded joints. The four sides of the enclosure shall be returned at the front to facilitate fixing of front cover plates. The front cover plates or doors shall be of box formation and flanged to facilitate fixing to the enclosure.
   3. The front cover of the switchboard shall be provided with grummets and dust seal to exclude dust and dirt. Meshed louver or ventilation vent with filter shall be provided at both sides for ventilation. All edges shall be rounded serrated star washers shall be fitted to ensure satisfactory earthling of the front cover.
   4. The switchboard shall undergo de-rusting treatment, anti-rust treatment and finished with epoxy dry-powder and oven baked semi-gloss enamel grey.

D. Distribution and consumer units:
   1. Shall comply with IEC 60439-3.
   2. Shall be surface or flush mounted metal clad or PVC type with hinged cover.
   3. Metal clad units shall be rust-proof and finished with epoxy dry-powder and oven baked enamel grey.
   4. Knockouts or other approved form of cable/conduit entries and suitable brass earthling bolt and nut shall be provided.
   5. The metal surfaces adjacent to any live part and all spaces between phases shall be protected by insulation barriers.

E. Meter panels:
   1. Shall be to the requirement of the icaal Power ElectSupply Authority.

F. Internal Components:
   1. Air Circuit Breaker(ACB) shall be of withdraw able metal clad flush mounted, horizontal draw out isolation and air break type suitable for installing on cubicle type of switchboard They shall be three or four poles type as specified and shall comply fully with IEC 60947-I and 60947-2.
   2. Molded case circuit breakers (MCCB) shall have the number of poles as specified in the Drawings and/or Bill of Quantities. They shall comply with IEC 60947-1 and 60947-2.
   3. Miniature circuit breakers (MCB) shall have a breaking capacity according to the drawings and bill of quantities and shall comply with IEC 60898-1 and IEC-60947-2.
   4. Residual current operated circuit breakers without integral overcurrent protection (RCCB) and residual current operated circuit breakers with integral overcurrent protection (RCCB) shall be current operated functionally independent of line voltage type, suitable for use on a 230/400V, 50 Hz. a.c. system. RCCB shall comply with IEC 61008-1I and 61008-2-1 and RCBO shall comply with IEC 61009-1 and 61009-2-1.
   5. Fuse Switches: Fuse-switches and switch-fuses shall be of totally enclosed flush or surface mounting, double air break, quick-make and quick-break type complete with phase barriers and fully comply with IEC 60947- I and 60947-3. They shall be of

utilization category AC-23A equipped with operating handle, position ON-OFF indicator and mechanical door interlock.

6. Isolating Switches: Isolating switches or switch dis-connector shall conform fully to IEC 60947-1 and 60947-3. They shall be able to operate continuously at full current rating without d e-rating capable of making and breaking currents under normal condition and when in open position, providing isolation from source of electrical energy for reasons of safety.
7. Electromechanical contactors and motor starters:
   a. Shall comply with and be type tested to IEC 60947-4-1.
   b. Each shall be of double air-break type with four pole, triple-pole, double-pole or single pole contacts as specified.
   c. Motor starter shall be of air-break triple-pole electromagnetic type.
   d. Unless otherwise specified, each starter shall comprise an isolating device, a thermal overload protective device, main and auxiliary contacts, on/off controls and indications.
   e. Both the main and auxiliary contacts shall be rated for uninterrupted and intermittent duty. The main contact of a contactor or starter shall be silver or silver-faced.
   f. Contactor and starter shall each have utilization category suitable for the particular application as shown in Table I of IEC 60947-4-1.
   g. Performance Requirements: Contactor and starter shall each be capable of making and breaking currents without failure under the conditions stated in Table VII and VIII of IEC 60947-4-1 for the required Utilization Categories and the number of operation cycle indicated.
   h. Co-ordination with Short-circuit Protective Devices:
      1) Contactor and starter shall comply with the requirements for performance under short-circuit conditions stipulated in IEC 60947-4-1.
      2) Type of co-ordination shall be Type “1” unless otherwise specified.

   i. Overload Relay:
      1) Overload relay for a starter shall be of thermal type unless otherwise specified.
      2) The trip class of starters shall be according to the classification in Table II of IEC 60947-4-1.

   j. Auxiliaries:
      1) Timer shall be pneumatic or solid state type.
      2) For star/delta and reversing starter, mechanical and electrical interlocks shall be fitted with the contactor.

8. Bus-bars:
   a. Shall conform to IEC 60439-1 and shall be tinned hard drawn high conductivity copper with an adequate uniform rectangular cross section to carry continuously their rated current without overheating. They shall be rigidly mounted on non-hygroscopic insulators so as to withstand any mechanical stresses to which they may be subjected under maximum fault condition.
   b. Bus-bar sizes must not be less than that specified in the Drawings. The bus-bars rating shall not be less than the rating of the incoming switchgear. All bus-bars, whether horizontal or vertical, shall be of the same size.
   c. The main bus-bars shall be run for the full length of the switchboard without reduction in size~ Neutral bus-bar shall be of full size and full length as the

phase bus-bars. Connections shall be made up with bronze or other copper alloy bolts and nuts utilizing tension washers on both outer faces.

d. The main bus-bar shall be arranged in a horizontal plane in the order red yellow-blue-neutral from back to front. Bus-bars shall be painted at appropriate points with colors red, yellow, blue and black to denote the phases.
e. Tinned copper earthing bar of cross sectional area shall run along the switchboard for its entire length This main earthing bar shall be fastened and bonded at the base to each vertical frame member of the switchboard At least one earthing bar of similar cross sectional area shall run the full height of the switchboard and connected to the main earthing bar. All earthing bars shall be identified with green and yellow (twin-colored) color.
f. Connections from bus-bars to the switchgears shall be effected by means of copper conductors securely clamped to the bus-bars and color coded to identify the phase and neutral conductors. Copper conductor either bare tinned bus-bars or insulated cable shall be rated in accordance with the current rating of the switchgear. Neutral conductor shall be of full size as phase conductor. Colored cable sleeve shall be shrouded for cable end termination.

9. Current transformes:
   a. Shall comply fully with IEC 60044- 1.
   b. Shall have short time rating not less than that of the switchboard in which they are incorporated.
   c. The secondary shall be rated for 5A.
   d. They shall be adequately rated in VA to carry the summation of all VA burdens of the connected loads.

10. Measuring instrument:
    a. Shall comply with relevant parts of IEC 60051.
    b. Shall be of panel flush mounting type with square plate finished matt black and pressed steel case.
    c. Shall be of industrial grade type adequately shielded against stray magnetic fields, conform to the measuring scales and arrangements and calibrated for correct readings.

11. Surge Protection Devices:
    a. Shall be of the type complying with IEC 61024-1 and IEC 61643- l, IEC 61312-1 and IEC 61 312-3.
    b. The surge protection device shall incorporate continuous indication of its protection status, viz. full protection present, reduced protection - replacement required and no protection - failure of protection.

2.02 MOTOR SWITCHGEAR, STARTERS AND CONTROL PANEL

A. Shall be a verified assembly as defined in IEC 61439- 2:2009 and constructed generally to Form 2.

B. Shall be of wall-mounted factory built assemblies of low voltage switchboard housing the motor starter and switchgear.

C. The panel shall be of steel construction, self-supporting, with modular top, side and back panels and doors of sheet steel built up on substantial framing with all necessary stiffeners, supports and return edges to provide a rigid construction and

clear accessibility to all internal components within the panel. The thickness of the sheet steel shall be at least 1.6 mm.

D. The panel enclosure shall be of degree of protection of IP 44 for indoor application to IEC 60529:2009. All doors shall have hinges and be provided with dust-excluding gasket.

E. All panels shall, but not be limited to, include the following operational features.
1. Local Auto/On/Off switch for each equipment.
2. Starter for each motor.
3. Fuse switch or circuit breaker for each equipment.
4. Isolating switch for each main incoming supply and for each motor starter.
5. Protective, control and auxiliary relays.
6. Current transformer.
7. Ameter for each equipment with phase selection switch for each motor.
8. Voltmeter.
9. Indicating lamps, push buttons, selectors and control switches; Emergency stop push buttons. and
10. Labelling.

2.03 AUTOMATIC TRANSFER SWITCHING EQUIPMENT

A. Shall be electromagnetically controlled at mains voltage, double air-break, four-pole type and tested to IEC 60947-4-1.

B. Shall be rated in Utilization Categories AC-3 and capable of making, breaking and carrying continuously the rated current and making on fault without overheating, damage or deterioration.

C. Shall be electrically and mechanically interlocked in operation.

D. Shall be automatic in response to the failure or resumption of supply mains.

E. Illuminated indicator for “Mains On” and “Essential Supply On” shall be provided at the cover of the compartment housing a changeover switch.

2.04 POWER FACTOR CORRECTION EQUIPMENT

A. General Requirements:
1. Shall include capacitors, protective devices, contactors, control relays, current transformers, cabinet, cables, cable glands, trunkings, control wirings, necessary accessories, etc. Blocking filter shall also be included to suppress harmonic and inrush currents.
2. Additional and specific requirements for the equipment shall be given in the Particular Specifications, the Drawings and Bill of Quantities.

B. Requirements of the Components:
1. Capacitor Units:
a. Shall comply with the requirement of IEC 60831 and IEC 60070.
b. shall be of low loss dry-type, metalized polypropylene (MPP) film type with self-healing properties and fitted in a sheet steel plate enclosure filled with non-inflammable medium.

c. Shall be hermetically sealed and manufactured from continuous metal foil and low loss high quality dielectric material.
d. Shall be provided with directly connected discharge resistors which shall reduce the residual voltage from the rated peak alternating voltage to 75V or less measured at the capacitor bank terminals within 3 minutes after disconnection from the source of supply. The discharge resistors shall be protected by an insulating cover.

2. Protection Units:
   a. The capacitor units shall be fed by fuse-switch or MCCB for protection against high fault currents.
   b. Besides, an overpressure disconnection device for protection against low fault currents shall be provided.
   c. H.R.C fuses and MCCB shall comply with the requirement of IEC 60269 and IEC 60947-2 respectively.

3. Control Relays:
   a. The capacitors in each bank shall be controlled by an automatic multi-step capacitor control relay capable of switching the appropriate amount of capacitors “IN” or “OUT” so as to achieve the best average power factor.
   b. The relay shall be commanded by a microprocessor which measures the reactive power of an installation and gives the necessary instructions to the relay for connecting or disconnecting the capacitors in order to maintain the desired power factor. The microprocessor shall be capable to ensure an uniform aging of contactors and capacitors by using a circular connection sequence which takes into account the time that each capacitor has been switched on.
   c. The control relay shall include a fully operational alarm system which shall operate in case the equipment cannot reach the required power factor.
   d. LED/LCD indicator shall be provided to show which step the capacitors are connected.

4. Contactors:
   a. The equipment shall be equipped with special contactor for limiting over-current on itself from high inrush current at capacitor switching.
   b. The contactors are characterized for having auxiliary contacts equipped with pre-charge resistors. These auxiliary contacts shall be closed before the power contacts such that the connection peak is strongly limited by the effect of the resistors.
   c. Contactors shall be adequately rated to make and break the capacitive current at low power factor. This current limitation increases the life of all the components of the equipment, in particular that of the protective devices and capacitors. The contactors shall comply with the requirement of IEC 60947-4-1.

5. Cabinet:
   a. The equipment shall be of cabinet type of at least IP31 (Indoor) and contained in a separate cubicle with control switchgear and all other necessary accessories and shall comprise multiple identical capacitor units connected and easily dismountable for its replacement.
   b. Integrated cubicle with the LV Switchboard installation is not acceptable. The equipment shall be installed in separate compartment segregated from the rest of the LV Switchboard such that failure of the equipment will not affect the

operation of the LV Switchboard. The equipment shall be housed in a front-access industrial grade enclosure with epoxy powder coating.

2.05 UNINTERRUPTABLE POWER SUPPLY UNIT (UPS)

A. General Requirements:
   1. Unit shall be a solid state secondary d.c. power supply unit operating in parallel with a battery bank.. The exact rated capacity shall be as per the design and bill of quantitities to supply a constant voltage current for the combined standing load as well as recharging and restoring the battery bank back to its constant potential voltage setting within the specified time limit after fully discharge.
   2. Unit shall consist of a rectifier bridge which has the a.c. mains input has the ripples of its d.c. output smoothed by a d.c. filter before supplying connected load under normal operation or the battery after discharging in a.c. mains failure.
   3. Unit shall be fully automatically controlled and switched by a control logic unit comprising the printed circuit boards (hereinafter called PCB).

B. Unit shall comply with IEC 62040-3.

C. Unit shall have sufficient voltage and rated capacity in ampere-hour rating to maintain the connected load at the rated output capacity for the duration specified.

D. The battery shall be sealed, high rate maintenance free nickel-cadmium type and shall have a proven life expectancy of at least 7 years.

E. Construction:
   1. The charger and battery set shall be housed in a industrial grade cabinet constructed from high quality steel sheet of minimum 1.2mm thick side and back plate and 1.5mm thick hinged front door with key lock.
   2. Protection class of the cabinet shall be not less than IP31 for indoor and IP55 for outdoor application as specified in IEC 60529.
   3. The entire enclosure surface shall be applied with chemical rust inhibitor, rust resisting primer coat and top coat to give maximum corrosion protection.
   4. The logic PCB, together with the isolation transformer and fused mains input terminals, shall be factory assembled on a plate located at the rear of the case.
   5. The power transistors are mounted on heat-sinks, separately from the PCB, on the back plate. The instruments and LED indicators are mounted on the front door of the cabinet. A lower ventilated compartment inside the cabinet provides adequate space for accommodation of the storage battery bank and ventilation.
   6. The cabinet shall be suitable for wall-mount or installation inside a switch cubicle where appropriate.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install switchboards in accordance with the standards, as shown on the drawings, and as recommended by the manufacturer.
   1. Self – Contained Cubicle Mounted Switchboard : bolted to mild steel channel base or anchored over concrete trench. The channel shall be anti- rusted and painted with a primer.

2. Pedestal Floor Mounted Switchboards: bolted to mild steel channel base or anchored over concrete trench. The channel shall be anti- rusted and painted with a primer.
3. Wall mounted Switchboards: firmly anchored to the wall or structure by means of bolts and nuts.
4. Distribution boards and consumer units: Anchored to surface or flush mounted.

3.02 FIELD QUALITY CONTROL

A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
   1. Visual Inspection and Tests:
      a. Compare equipment data with specifications and
      b. Inspect physical, electrical, and mechanical condition.
      c. Verify appropriate anchorage, required area clearances, and correct alignment.
      d. Verify that circuit breaker sizes and types correspond to the bill of quantities.
      e. Verifying tightness of accessible bolted electrical connections.
      f. Clean switchboard enclosure interior. Clean switchboard enclosure exterior.
      g. Inspect insulators for evidence of physical damage or contaminated surfaces.
      h. Verify correct shutter installation and operation.
      i. Exercise all active components.
      j. Verify the correct operation of all sensing devices, alarms, and indicating devices.

   2. Electrical tests:
      a. Perform insulation-resistance tests on each bus section.
      b. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.

3.03 FOLLOW-UP VERIFICATION ONTROL

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the switchboard is in good operating condition and properly performing the intended function.

3.04 WARNING SIGN

A. Mount on each entrance door of the clearly lettered warning sign for warning personnel.

3.05 ONE LINE DIAGRAM AND SEQUENCE OF OPERATION

A. At final inspection, an as-built one line diagram shall be laminated or mounted under acrylic glass, and installed in a frame mounted in the switchboard room or in the outdoor switchboard enclosure.

END OF SECTION

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SECTION 262726

WIRING DEVICES

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for Electrical Installations: Section 260511.

B. Low-Voltage Electrical Power Conductors and Cables: Section 260519.

C. Grounding and Bonding for Electrical Systems: Section 260526.

D. Raceway and Boxes for Electrical Systems: Section 260533.

E. Lighting: Section 265100.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Code of Standard. Electrical Installation of Buildings.

B. ES IEC 60884: Plugs and Sockets for Household and Similar Purposes.

C. ES IEC 60669-1: Switches for Household and Similar Fixed-Electrical Installations – Part-1, General Requirements.

D. ES IEC 60309-2: Plugs, Socket-Outlets and Couplers for Industrial Purposes.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical Installations.

B. Product Data:
   1. Submit the product catalogue of all the wiring devices to be used in compliance with the drawings and Bill of Quantities.

C. Certifications: Prior to final inspection, submit the following:
   1. Certification by the Contractor that the wiring devices have been properly installed and adjusted.

1.04 QUALITY ASSURANCE

A. Refer to Paragraph, Qualifications (Products and Services), In Section 260511, Requirements for Electrical Installations.

PART 2 PRODUCTS

2.01 SOCKET OUTLETS

A. Household and similar socket outlets, single phase:
   1. Shall comply with ES-IEC 60884.
   2. Shall be the CEE 7/4 type (Schucko), rated at 16A , 250V, featuring two round pins of 4.8 mm diameter (19 mm long, centers 19 mm apart) for the line and neutral contacts, plus two flat contact areas on the top and bottom side of the plug for protective earth (ground). Has a cavity into which the plug is inserted.

B. Industrial socket outlets single phase and three phase:
   1. Shall comply with ES-IEC 60309.

2.02 SWITCHES

A. Shall comply with ES-IEC 60669.

B. Shall be generally flush type unless otherwise specified.

C. Shall be rated at 10A unless otherwise specified.

D. Shall be suitable for use in inductive circuits.

2.03 BOXES FOR SOCKET OUTLETS AND SWITCHES

A. Shall comply with ES-IEC 60670.

B. Shall be manufactured from thermoplastic resins and able to withstand installation temperatures of up to 60 DEG C.

C. Shall be selected to suit each device.

D. All wiring devices should be from the same manufacturer as practicable as possible.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Installation shall be in accordance with EBSC 10, ES and IEC and as shown as on the drawings.
   2. Install wiring devices after wall construction and painting is complete.
   3. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.
   4. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades.

B. Installation of switches:
   1. Shall be installed at 1200 from floor finish with the toggle OFF position down.

2. Exact positions of switches shall be checked for the arrangement of door swings and other fixtures.

C. Installation of socket outlets:
   1. Shall be installed generally at 300 from floor finish and at 1350 in kitchens.

D. Installation of Industrial Sockets:
   1. Shall be according to the drawings and Bill of quantities.

3.02 ACCEPTANCE CHECKS AND TESTS

A. Inspect physical and electrical condition.

B. Test wiring devices for damaged conductors, high circuit resistance, poor connections, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION

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SECTION 263213

ENGINE GENERATORS

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for Electrical Installations: Section 260511.

B. Low-Voltage Electrical Power Conductors and Cables: Section 260519.

C. Grounding and Bonding for Electrical Systems: Section 260526.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Standard Code . Electrical Installation of Buildings.

B. IEC 60034-1: Rotating Electrical Machines.

C. ISO 8528 Part I: Reciprocating Interal Combustion Engine Drive Alternating Current Generating Sets.

D. ISO 3046: Reciprocation Internal Combustion Engines, Performance.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical Installations.

B. Diagrams:
   1. Control system diagrams, control sequence diagrams or tables, wiring diagrams, interconnections diagrams (between engine generators, automatic transfer switches, paralleling switchgear, local control cubicles, remote annunciator panels, and fuel storage tanks, as applicable), and other like items.

C. Technical Data:
   1. Published ratings, catalog cuts, pictures, and manufacturer’s specifications for engine, altermnator, governor, voltage regulator and control and supervisory equipment.
   2. Description of operation.

D. Deration:
   1. Performance derations appropriate to installed environment.

E. Manuals:
   1. When submitting the shop drawings, submit complete maintenance and operating manuals, to include the following:
      a. Technical data sheets.
      b. Wiring diagrams.

c. Include information for testing, repair, troubleshooting, and factory recommended periodic maintenance procedures and frequency.
d. Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.

F. Test Reports:
1. Submit certified factory test reports.
2. Submit field test reports prior to the final inspection.
3. Prior to installation of the engine generator at the job site, submit certified factory test data.
4. Prior to the final inspection, submit the following:
a. Certification by the Contractor that the engine generators have been properly installed, adjusted, and tested.

1.04 QUALITY ASSURANCE

A. Refer to Paragraph, Qualifications (Products and Services), In Section 260511, Requirements for Electrical Installations.

1.05 STORAGE AND HANDLING

A. Engine generators shall withstand shipping and handling stresses in addition to the electrical and mechanical stresses which occur during operation of the system.

B. Store the engine generators in a location approved by the Engineer in Charge.

1.06 JOB CONDITIONS

A. Job conditions shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures, and arrangements of the engine generator system shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The engine generator system shall be in accordance with IEC, ISO and as specified herein.

B. Provide a factory-assembled, wired (except for field connections), complete, fully automatic engine generator system.

C. Engine generator parameter schedule:
1. Power Rating: Prime power / Standby Power.
2. Voltage: 400/230V.
3. Rated Power: As specified on the Drawings and Bill of Quantities in KW/KVA (continuous).
4. Power Factor: 0.8lagging.
5. Engine generation application: Standby, unless otherwise specified.
6. Fuel: diesel.

7. Voltage Regulation: +/- 2% (maximum) (No Load to Full Load) (standalone applications).
8. Phases: 3 Phase with neutral (WYE).
9. Each component of the engine generator system shall be capable of operating at the specified altitude above sea level, which will have average ambient air temperature ranging from a minimum to maximum of specified temperature.

D. Assemble, connect, and wire the engine generator at the factory so that only the external connections need to be made at the construction site.

E. Engine Generator Unit shall be factory-painted with manufacturer's primer and standard finishes.

F. Connections between components of the system shall conform to the recommendations of the manufacturer.

G. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened, and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.

H. Engine generator shall have the following features:
1. Factory-mounted on a common, rigid, welded, structural steel base.
2. Engine generator shall be statically and dynamically balanced.
3. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
4. Shall be capable of operating satisfactorily as specified for not fewer than 10,000 hours between major overhauls.

2.02 ENGINE

A. The engine shall be coupled directly to a generator.

B. Minimum four cylinders.

2.03 GOVERNOR

A. Shall be isochronous, electronic type.

2.04 LUBRICATION OIL SYSTEM

A. Shall be pressurized type.

2.05 FILTERS

A. Filters shall be cleanable or replaceable type.

2.06 FUEL SYSTEM

A. Main fuel storage tank:
1. Shall be provided on the base frame unless otherwise specified.
2. Should be easy to clean.
3. Should be equipped with visual fuel level indicator.

B. Day Tank: (Optional):
   1. Capacity shall be as per the Drawings and Bill of Quantities.

2.07 COOLING SYSTEM

A. Liquid-cooled, closed loop, with integral engine driven circulating pump.

B. Cooling capacity shall not be less than the cooling requirements of the engine generator and its lubricating oil while operating continuously at 100% of its specified rating.

C. Coolant shall be extended-life antifreeze solution with corrosion inhibitor additive as recommended by the manufacturer.

2.08 AIR INTAKE AND EXHAUST SYSTEMS

A. Air Intake:
   1. Provide an engine-mounted air cleaner with replaceable dry filter.

B. Exhaust System:
   1. Where a turbocharger is required, they shall be engine-mounted, driven by the engine gases, securely braced against vibration and adequately lubricated by the engine's filtered lubrication system.
   2. Exhaust Muffler shall be with noise attenuation.
   3. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine generator while it is delivering 100% of its specified rating.
   4. Exhaust pipe size from the engine to the muffler shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two pipe sizes larger than engine exhaust pipe.
   5. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.

C. Exhaust Piping and Supports: Black steel pipe, ASTM A-53 standard weight with welded fittings. Spring type hangers shall support the pipe.

D. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing rain cover.

2.09 ENGINE STARTING SYSTEM

A. The engine starting system shall start the engine at any position of the flywheel.

B. Electric cranking motor:
   1. Shall be engine-mounted.
   2. Shall crank the engine via a gear drive.
   3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five consecutive starting attempts of 10 seconds cranking each at 10-second intervals, for a total of 50 seconds of actual cranking without damage.

C. Batteries shall be high discharge rate type.

D. Battery Charger:
   1. A current-limiting battery charger shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition.
   2. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage.

2.10 ALTERNATOR

A. Shall be Synchronous, rotating-field type connected directly to the engine.

B. Shall be provided with Lifting lugs designed for convenient connection to and removal from the engine.

C. Shall be designed for sustained operation at 100% of the RPM specified for the engine generator without damage.

D. Furnished with brushless excitation system or static-exciter-regulator assembly.

E. Nameplates attached to the alternator shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, kW/kVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phases and frequency, and date of manufacture.

2.11 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Shall comply with IEC 60947-2.

B. Shall be 100% rated.

2.12 CONTROLS INDICATION AND PROTECTION

A. Shall include Engine Generator Control Cubicle(s) and Remote Annunciator Panel (If so specified on the drawings and Bill of Quantities.
   1. Coordinate controls with the automatic transfer switches shown on the drawings so that the systems will operate as specified.

B. Engine generator Control Cubicle:
   1. Starting and Stopping Controls:
      a. A three-position, maintained-contact type selector switch with positions marked "AUTOMATIC," "OFF," and "MANUAL.".
      b. A momentary contact push-button switch with positions marked.

   2. Engine Cranking Controls:
      a. The cranking cycles shall be controlled by a timer that will be independent of the battery voltage fluctuations.

   3. Supervisory Controls:
      a. Overcrank: If one cycle of starting attempt is completed without starting the engine, a signal and audible alarm shall be energized. The cranking control system shall lock-out.

b. Coolant Temperature: Generator stops if limit teperature reached.
c. Coolant level: a signal and audible alarm is shown if low.
d. Libricating Oil Pressure: Generator is shut down if lower pressure limit reached.
e. Overspeed: Generator stops when limit is reached.
f. Fuel level: a signal and audible alarm is shown if low level reached.
g. Reset Alarms and Signals: Over-crank, Coolant Temperature, Coolant Level, Oil Pressure, Over-speed, and Low Fuel signal lights and the associated audible alarms shall require manual reset.

4. Automatic Voltage Regulator:
   a. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.

2.13 REMOTE ANNUNCIATOR PANEL (OPTIONAL)

A. A remote annunciator panel shall be installed at location as shown on the drawings.

B. Include control wiring between the remote annunciator panel and the engine generator. Wiring shall be as required by the manufacturer.

2.14 SOUND-ATTENUATED ENCLOSURE (OPTIONAL)

A. The engine generator and related equipment shall be housed in an outdoor weatherproof enclosure.

B. Enclosure shall be sound-attenuated (maximum 85 dBA at 1525 mm. Sound ratings shall be based on full load condition of engine generator in a single unit operation condition.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install concrete bases of dimensions shown on the Drawings.

B. Installation of the engine generator shall comply with manufacturer's written instructions.

C. Mounting:
   1. Support the base of engine generator on vibration isolators, each isolator bolted to the floor (pad), and the generator base bolted to isolator.
   2. All connections between the engine generator and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.

D. Connect all components of the generator system so that they will continue to be energized during failure of the normal electrical power supply system.

3.02 ACCEPTANCE CHECKS AND TESTS

A. When the complete engine generator systems have been installed and prior to the final inspection, test all components of the system in the presence of the Engineer in Charge

for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.

B. Furnish fuel oil, lubricating oil, anti-freeze liquid, water treatment, and rust-inhibitor for testing of the engine generator.

C. Visual Inspection: Visually verify proper installation of engine generator and all components.

D. Field Tests:
   1. Perform manufacturer's after-starting checks and inspections.
   2. Test the engine generator.
      a. If during test, an engine generator failure occurs, the test(s) are null and void. After repair and/or adjustments, the test(s) shall be repeated at no additional cost.

   3. Demonstrate that the engine generator will attain proper voltage and frequency within the specified time limit from a cold start after the closing of a single contact.

E. Automatic Operation Tests:
   1. Test the engine generator and associated automatic transfer switches to demonstrate automatic starting, loading and unloading. The load for this test shall be the actual connected loads. Initiate loss of normal source and verify the specified sequence of operation. Restore the normal power source and verify the specified sequence of operation. Verify resetting of controls to normal.

3.03 FOLLOW-UP VERIFICATION

A. After completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the engine generator(s) and control and annunciation components are in good operating condition and properly performing the intended function.

3.04 INSTRUCTIONS AND FINAL INSPECTIONS

A. Mount a set of operating instructions for the system and install instructions within a frame mounted on the wall near the engine generator at a location per the Engineer.

B. Furnish the services of a competent, certified technician for one 4-hour period for instructions to client in operation and maintenance of the equipment, on the date requested by the Engineer.

END OF SECTION

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SECTION 264100

FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for Electrical Installations: Section 260511.

B. Grounding and Bonding for Electrical Systems: Section 260526.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Standard Code. Electrical Installation of Buildings.

B. ES IEC 62305 1: Protection against lightning Part 1; General Principles.

C. ES IEC 62305 3: Protection Against Lightning Part 3; Physical Damage to Structures and Life Hazard.

D. IEC 62305: Protection Against Lightning.

E. IEC 61238: Compression and Mechanical Connectors for Power Cables for Rated Voltages up to 30 kV.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical Installations.

B. Drawings:
   1. Submit as per built drawings before acceptance of the Lightning Protection System Installation works.
   2. Show locations of air terminals, connections to required metal surfaces, down conductors, and grounding means.
   3. Show the mounting hardware and materials used to attach air terminals and conductors to the structure.

C. Product catalogues:
   1. Submit the catalogues of the components of the Lightning Protection System to be installed.

D. Certifications: Prior to final inspection, submit the following:
   1. Certification by the Contractor that the lightning protection system has been properly installed and inspected.

1.04 QUALITY ASSURANCE

A. Switchboards shall be thoroughly tested to assure that there are no electrical or mechanical defects.

B. The following additional tests shall be performed:
   1. Verify that circuit breaker sizes and types correspond to drawings.
   2. Verify tightness of bolted electrical connections.
   3. Exercise all active components.
   4. Perform an insulation-resistance test.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. A lightning protection system: Shall be made of materials that are resistant to corrosion or shall be acceptably protected against corrosion.

B. No combination of materials that forms an electrolytic-couple of such nature that, in the presence of moisture, corrosion is accelerated shall be used.

C. One or the following materials are acceptable:
   1. Copper.
   2. Copper alloy.
   3. Aluminum.
   4. Galvanized steel.

D. Lightning protection components shall conform to EBSC-10, ES, and IEC.

E. The type and minimum size of component parts of the Lightning protection System shall be as provided in Table 7.3 of EBSC-10 Section 7 Part II.

2.02 PRODUCTS

A. Air Terminals:
   1. Air Terminal Strips: Aluminum, Copper or Galvanized Steel.
   2. Air Termination Rods: copper, aluminum, aluminum alloy, bronze, or galvanized steel.
   3. Vertical air terminations shall be made of solid or tubular rods.
   4. Horizontal air terminations shall be made of solid conductor, strips or cables.
   5. Roofing sheet may be part of the Air Terminal System if it has a thickness greater than the sizes specified on table 7.5 of EBSC-10 Section 7 Part II.

B. Conductors:
   1. Conductors shall be Copper, Aluminum or Galvanized Steel.
   2. Conductors shall be in the form of multiple strand cables, single wires, rods, or flat strips.
   3. Structural frame of the building may be used as the main conductor of a lightning protection system if it is either electrically continuous or made so.

C. Earth Terminations:
   1. Earthling Rods.

a. Copper clad steel, Galvanized Steel, Steel, hard drawn copper or Stainless Steel rod.
b. Iron, copper or galvanized steel strip.
c. Solid or stranded copper wires.

2. Earthling plates.
   a. Copper or Galvanized steel or
   b. A combination of the above as specified in the drawings and bill of quantities.

D. Bonding plates, Anchors, Fasteners and Connectors: Should be to suit the used main components with Galvanic Compatibility.

E. Exothermic weld materials.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be coordinated with the roofing manufacturer and installer.

B. Install the conductors as inconspicuously as practical.

C. Install the down conductors within the concealed cavity of exterior walls where practical. Run the down conductors to the exterior at elevations below the finished grade.

D. Where down conductors are subject to damage or are accessible near grade, protect with down conductor guards to 1.8 m above grade. Bond down conductors guards to down conductor at both ends.

E. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.

F. Install ground rods as below:
1. Deep moist clay soil:
   a. Earthling rod shall extend vertically not less than 3.0m into the earth.
   b. The ground shall be compacted and made tight against the full length of the conductor or earth rod.

2. Sandy or gravely soil:
   a. two or more 'earth rods at not less than 3.0m spacing shall be driven vertically to a minimum depth of 3.0m below grade.

3. Shallow top soil:
   a. If bedrock is neat the surface, the conductor shall be laid in trenches extending away from the building at each down conductor.
   b. Trenches in (1) above shall at least be:
      1) 3.7m long and 610,0mm deep in clay soil.
      2) 7.3m long and 610.0mm deep in sandy or gravely soil.
      3) If these methods should prove impracticable, the lightning protection cable may be laid directly on the bedrock with a minimum distance of 610.0mm from the foundation or exterior footing and terminate by attachment to a

buried copper earth plate at least 0.8mm thick and having a minimum surface area of $0.18m^2$.

G. Exothermically welded connections should be observed by engineer in Charge before they are covered.

H. Bond down conductors to metal main water piping where applicable.

I. Bond down conductors to building structural steel where applicable.

J. Connect roof conductors to all metallic projections and equipment above the roof as indicated on the drawings.

K. Connect exterior metal surfaces, located within 900 mm of the conductors, to the conductors to prevent flashovers.

L. Maintain horizontal or downward coursing of main conductor and ensure that all bends have at least a 203 mm radius and do not exceed 90 degrees.

M. Conductors shall be rigidly fastened according spacing specified on Table 7.5 of EBSC-10 Section 7 Part II.

N. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure.

O. Install air terminal bases, cable holders and other roof-system supporting means without piercing membrane or metal roofs.

P. Where the structural steel framework or reinforcing steel is used as the down conductor:
   1. Weld or bond the non-electrically-continuous sections together and make them electrically continuous.
   2. Verify the electrical continuity by measuring the ground resistances to earth at the ground level, at the top of the building or stack, and at intermediate points.
   3. Connect the air terminals together with an exterior conductor connected to the structural steel framework at not more than 18 m intervals.
   4. Install ground connections to earth at not more than 18 m intervals around the perimeter of the building.
   5. Weld or braze bonding plates to cleaned sections of the steel and connect the conductors to the plates.
   6. Do not pierce the structural steel in any manner.

Q. Earth rod connection:
   1. Earth rod connections shall be made by welding, bracing or clamping.
   2. Clamps shall be secured with at least two bolts or screw caps and shall make Contact with the earth rod for at least 380.0mm.
   3. The point of connection of the earth termination network shall be removable and easily accessible from above earth to facilitate inspection, testing and maintenance of the lightning protection system.
   4. If below ground, the point of connection shall preferably be housed in a purpose-built inspection pit or chamber.

3.02 ACCEPTANCE CHECKS AND TESTS

A. Test the ground resistance to earth by standard methods, and conform to the ground resistance requirements specified in Section 260526, Grounding and Bonding for Electrical Systems.

B. Below-grade connections shall be visually inspected by the Engineer in Charge prior to backfilling. The Contractor shall notify the Engineer in Charge before the connections are ready for inspection.

END OF SECTION

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Ministry of Construction

SECTION 265100

LIGHTING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements for Electrical Installations: Section 260511.

B. Low-Voltage Electrical Power Conductors and Cables: Section 260519.

C. Grounding and Bonding for Electrical Systems: Section 260526.

D. Wiring Devices: Section 262726.

1.02 REFERENCES

A. EBSC-10:2015: Ethiopian Building Standard Code . Electrical Installation of Buildings.

B. IEC 60364: Electrical Installation for Buildings.

C. ES IEC 60227: PVC insulated cables Non sheathed/Sheathed /Flexible.

D. ES IEC 60432-2: Incandescent Lamps (Tungsten Halogen Lamps).

E. ES 1359: Tubular Fluorescent Lamps for General Lighting.

F. ES IEC 6015: Glow Starters for Fluorescent Lamps.

G. ES IEC 60192: Low Pressure Sodium Vapor Lamps.

H. ES 1430: Luminaires , General Purpose.

I. ES 1431: Luminaires, Ememrgency.

J. ES 1449: Photometric Data for Luminaires , Measurement.

K. ES 1450: Photometric data measurement, Battery Operated Emergency Luminaires.

L. IEC 60598: Luminaires.

M. IEC 60662: High Pressure Sodium Lamps.

N. IEC 60188: High Pressure Mercury Lamps.

O. IEC 60969: Self Ballasted Compact Fluorescent lamps.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 260511, Requirements for Electrical Installations.

B. Product Data:
   1. Submit product catalogues of the type of Lighting Fixtures to be installed. Prior to delivery.

C. Quality Control Submittals:
   1. Certifications: Prior to final inspection, submit the following:
      a. Certification by the Contractor that the interior lighting systems have been properly installed and tested.

1.04 QUALITY ASSURANCE

A. Refer to Paragraph, Qualifications (Products and Services), In Section 260511, Requirements for Electrical Installations.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. General:
   1. Luminaires together with lamp, lamp holders, control gear and other associated accessories shall, as a minimum requirement, conform to the relevant parts and/or sections of ES 1430/1431 and IEC 60598.
   2. All luminaries shall be fully assembled, completed with lamp, control gear, internal wiring etc. . Internal wires shall be terminated in terminal blocks in an approved manner. Wiring shall be of heat resistant insulated colored cables. The terminal blocks shall be suitably rated and clearly labelled for connection to external wiring.
   3. All metal parts of the luminaries shall be effectively earthed and supplied with an approved earth terminal.
   4. All components of the luminaries shall be able to withstand a voltage range of +50 to -10% of the rated voltage. All discharge type luminaries shall be power factor corrected to at least 0.9 lagging using dry type capacitor.

B. Incandescent or compact fluorescent luminaires:
   1. Incandescent lamps:
      a. Shall be of G.LS type complying with ES-IEC 60432, IEC 60061 and IEC 60064.
      b. Shall be guaranteed for a minimum of 1000 hours life at the rated voltage.
      c. Shall be pearl' type for open type or louvered type of luminaries and 'clear' type for totally enclosed type of luminaires.

   2. Compact Fluorescent lamps:
      a. Shall comply with IEC 60969 and IEC 60061.

   3. Bulkhead luminaries:
      a. Shall have the body made of pressure diecast aluminum and provided with removable knockouts for conduits/cable entry.

b. The diffuser shall be anti-vandal polycarbonate. A neoprene gasket shall be provided to seal the diffuser to the body so as to ensure the luminaries is weatherproof.
c. The lamp holder shall be BC porcelain type.
d. A heat resistant sleeving shall be provided to protect the incoming cable.

4. Globe luminaries:
   a. Shall have satin etched white glass sphere complete with screw neck.
   b. The base shall be of porcelain.
   c. The lamp holder shall be bayonet cup porcelain type.

C. Fluorescent Luminaire:
1. Shall comply to ES ES 1430 and IEC 60598.
2. Shall have housing made from good quality mild steel sheet of minimum thickness 0.50 mm and shall be of sound and rigid construction suitable for suspended installation. The metalwork shall be rust inhibited to prevent corrosion and shall be sprayed with an undercoat of zinc chromate primer and finished with two coatings of super white baked enamel.
3. All components in the luminaire shall be guaranteed for a minimum of 2000 hour life.
4. Magnetic Ballast:
   a. shall comply with , IEC 60920 and IEC 60921.
   b. Shall be polyester resin impregnated silent operation type fitted with terminal block for easy wiring For 18 watts and 36 watts fluorescent tubes.
   c. The watt loss of the ballast shall be not more than 8 watts.
   d. The mounting of the ballast shall be in such a way that easy dismantling and replacement can be effected within the casing.

5. Electronic Ballast:
   a. Shall comply with , IEC 60920 and IEC 60921.
   b. Shall also be in compliance with EN 55015 for radio frequency interference suppression and IEC 61000-3-2 for harmonics distortion.
   c. They shall be of instant starting, non-dimming, low in-rush starting current and low leakage current type.
   d. Rated maximum operating temperature the case shall not exceed 70 ^{o}C.
   e. Power loss through the ballast shall not be more than 2 watt.
   f. Shall operate and maintain consistent light output over voltage variation from -10 % to +5 % of the rated voltage and power factor of not less than 0.95.
   g. Overvoltage protection at 350 volts and automatic shutdown in the event of lamp failure shall also be incorporated.
   h. For single ballast controlling two fluorescent lamps in one luminaires, if one fluorescent lamp is burnt out, the other fluorescent lamp shall continue to operate without the burnt lamp being replaced the other fluorescent lamp shall continue to operate without the burnt lamp being replaced.

6. Capacitor:
   a. Shall comply with IEC 61048 and IEC 61049.
   b. Hall be of dry, self-healing, metalized polypropylene type.
   c. 'U'-shaped tool clip shall be provided to hold the capacitor in position.

7. Starter:

a. Sshall comply with ES IEC 60155 and the starter holders comply with IEC 60400.
b. For the single channel luminaries the starter shall be fitted at the side of the casing. In cases where starters are to be fitted from the outside of the luminaire casing, the starter holders shall be installed in such a way that the starters shall not protrude out of the casing by more than 10 mm.

8. Lampholders:
   a. Shall comply with IEC 60400.
   b. Shall be of robust and well-designed construction suitable for bi-pin fluorescent tubes.

9. Fluorescent tubes:
   a. Shall comply with IEC 60081.
   b. Shall be bi-pin type.
   c. Unless otherwise specified the color temperature of the tube shall be approximately 4000 K.
   d. The light output, after 100 hours, shall not be less than 1350 lumens for 18 W tube and 3350 lumens for 36W tube.
   e. Each fluorescent tube with rating of 36 W or more shall be provided with its own ballast.

10. Wiring (within) of Fluorescent Luminaire:
    a. Shall be carried out with heat resistant cable.
    b. Shall be done in a neat way with holder to hold the cable in position and also to avoid contact with heat producing components.
    c. Cables shall be terminated in a termination block marked _L' and _N' for connection to the incoming wires.
    d. A brass screw type earth terminal shall be provided in the casing near the termination block for earth connection. This earth terminal shall be clearly marked with the standard earth terminal symbol.

11. Louvers, Reflectors and diffusers:
    a. Louvers and reflectors for the luminaires shall be made of high purity anodized aluminum with low iridescent mirror finished.
    b. The prismatic and opal diffuser shall be made of UV-stabilized flame retardant polystyrene/acrylic panel.
    c. Louvers, reflectors and diffusers shall give good even light distribution with minimal glare in both the axial and transverse planes.
    d. Photometric data for the luminaires shall be made available and submitted to Engineer in Charge when required.

D. Self Contained Emergency Luminaires:
   1. Shall comply with ES 1431 and IEC 60598-2-22.
   2. The body shall be of folded steel, polycarbonate or anodized aluminum construction.
   3. The diffuser shall be of prismatic polycarbonate.
   4. They shall be completed with maintenance-free high temperature rated sealed nickel cadmium battery, solid state automatic charger, changeover device, fluorescent lamp, indicator lamp, test switch and interior disconnecting switch. The battery shall be fully rechargeable to its operational capacity in not more than 24 hours after

discharge. Low volt cut-off safety feature shall be incorporated to prevent over discharge of battery.

5. The fluorescent tube shall be 8 watt of color temperature 3500 K and lumen output of 480 lumens type. The duration for emergency operation shall not be less than 3 hours. The initial lumen output of the self-contained emergency luminaires shall be not less than 25% of the lumen output of the fluorescent tube. The lumen output at the end of the rated duration shall be minimum 10% of the lumen output of the fluorescent tube.

E. High pressure discharge lamp and luminaire:

1. High pressure sodium vapor discharge lamp (son-t and son-e):
   a. Shall be manufactured and tested in accordance with IEC 60662.
   b. The lamp shall consist of a high pressure sodium discharge operating within a sintered alumina arc tube.
   c. The arc tube shall be mounted in a clear glass bulb complete with an E40 (GES) cap. The lamp shall have a universal operating position and shall be suitable for use with external igniter.
   d. The correlated color temperature of the lamp shall be in the order of 2000 °K.
   e. The light output of the lamp shall be constant and shall not be less than the following figures for the respective wattage type in the initial 2000 hours:

Nominal Lamp Wattage	Initial Light Output
150W	16000 lumens
250W	28000 lumens
400W	48000 lumens

   f. The rated average life of the lamp shall not be less than 24000 hours at 50% Failure.

2. High pressure mercury vapor discharge lamp (MBF):
   a. The lamp shall be manufactured and tested in accordance with IEC 60188 or the equivalent BS 3677.
   b. The lamp shall consist of a high pressure mercury discharge operating within a quartz arc tube.
   c. The arc tube shall be mounted in an elliptical glass bulb coated with a fluorescent phosphor and complete with a cap of the type compatible with the respective lamp wattage type.
   d. The correlated color temperature of the lamp shall be in the range of 3400°K to 4000°K with respective to the selected nominal lamp wattage.
   e. The lamp shall have a universal operation position.
   f. The light output of the lamp shall be constant and shall not be less than the following figures for the respective wattage type in the initial 2000 hours.

Nominal Lamp Wattage	Initial Light Output
50W	1800 lumens
80W	3700 lumens
125W	6500 lumens
250W	13000 lumens
400W	22000 lumens

g. The rated average life of the lamp shall not be less than 16000 hours or 24000 hours with respective to the selected nominal lamp wattage at 50% failure.

F. Luminaire accepting high pressure sodium/mercury discharge lamp for street lighting:

1. General:
   a. Shall be manufactured in accordance with IEC 60598.3.
   b. Luminaires shall be robustly constructed, weatherproof, hail proof, insect proof, corrosion proof, solar (including ultra-violet) resistant and vandal resistant.
   c. In order to prevent risks associated with road safety, luminaires shall be designed to avoid disintegration in the event of vehicular impact. Luminaire housings shall be secured to the pole spigot in such a manner that the control gear compartment remains attached to the pole spigot even after a severe impact.
   d. All external parts and components of the luminaire shall be designed to shed water and no accumulation of condensation or precipitation shall occur. An exterior lip shall be provided on the housing to ensure that there is no direct rainwater contact with the gasket between the housing and the diffuser, thus ensuring that no moisture is sucked into the diffuser when the luminaire is switched off and cools down.
   e. Luminaires shall be constructed from durable lightweight materials. Deterioration shall not occur due to electrolytic action or by differential thermal expansion.
   f. Ferrous components shall be hot-dip galvanized for heavy-duty applications. External small components (clips, screws, bolts, nuts, washers, etc.) shall be manufactured from stainless steel (grade 304 or better).

2. Mounting:
   a. Spigot entries shall be designed to fit easily over the bracket pipe and shall be truly parallel to the fitting.
   b. Spigot entries shall be constructed of corrosion-resistant materials and compatible with the galvanized mild steel spigot such that deterioration by electrolytic action shall not occur.
   c. Luminaires shall be secured to the spigot by means of at least two stainless steel M10 hexagonal head screws. The construction of the housing shall be such that cracking cannot occur during the process of fixing the luminaire to the pole or bracket.
   d. Luminaires should incorporate a positive and substantial means of fixing to the pole or bracket, designed to allow adjustment and to ensure that once set to the required position, the luminaires remain locked in that position.

3. Diffusers:
   a. Diffusers shall have no external prisms that could accumulate dirt and thus reduce the light output of the luminaire. Diffusers shall be constructed in such a manner that the wall thickness of the material is maintained at a constant thickness, hence preventing the projection of lines of patterns onto the road surface. Diffusers shall be heat-resistant and shall not discolor, even after prolonged exposure to light, both atmospheric and artificial. The mechanical strength shall be sufficient to prevent warping or distortion to occur. Diffusers shall be manufactured from injection molded high impact acrylic.
   b. Devices for locking the bowl to the luminaire shall be at least three stainless steel clips thus ensuring that it remains closed in the event of the failure of one clip. Hinges and clips shall be robust and simple to operate. Devices such as

wing nuts and those requiring the use of a tool (e.g. screws) shall be rejected. Bowls that are completely flat, i.e. do not project below the luminaire body, will not be acceptable.

c. Diffusers shall have a means to prevent direct contact by rainwater with the one-piece gasket, which shall be permanently fitted into the housing (e.g. in a tongue and groove arrangement). The gasket shall form a seal when the diffuser is in the closed position, preventing the entry of dust, moisture and insects into the lamp compartment. The gasket shall be made from silicon sponge, which shall not be subject to permanent compression or deterioration in service. The gasket should be fitted into a groove in the housing and should be kept in place by a tongue provided on the diffuser, thus ensuring the integrity of the IP rating and shall not work loose during maintenance of the luminaire.

d. Luminaire bowls shall be capable of being removed from the luminaire body simply by unclipping for cleaning purposes. The bowl shall not detach from the luminaire body in the unlikely event of the bowls being left in the open or hanging position when mounted on the pole. The diffuser should also remain attached to the housing when hinged open for maintenance or lamp replacement. This hinge mechanism should be incorporated into housing to ensure that it is protected against damage during transport, installation and maintenance.

4. Lamp-holders and brackets:
   a. Lamp-holders shall comply shall be capable of maintaining efficient electrical contact with the lamp terminals without deterioration due to temperature, climatic conditions and vibration which will be encountered in service.
   b. For additional insulation against igniter spark-over a suitable fiber washer for E40 GES lamp holders shall be used.
   c. Lamp-holders shall be rated to withstand 240°C and be rated at the appropriate lamp ignition voltage.
   d. A lamp fully inserted into the lamp-holder shall be rigidly held with its axis substantially coincident with that of the lamp-holder under conditions of wind, vibration and mechanical shock to be expected in service.
   e. The lamp-holder shall have zero degree rake i.e. its axis shall be parallel to that of the spigot entry.
   f. Lamp holder brackets and lamp supports shall accept and retain lamps which are within the dimensional tolerances stated in the appropriate lamp standard and shall locate the light source in the correct relationship to the optical control devices of the luminaire. With luminaires for lamps of greater rating than 150W, the lamp holder shall be mounted firmly to an aluminum bracket.
   g. Alternatively the lamp holder is to be mounted directly onto aluminum bosses, which protrude into the lamp housing from the gear compartment.

5. Reflectors:
   a. Reflector surfaces shall be of high-grade 99.98% super pure deep anodized aluminum.
   b. Reflectors or any other light-controlling component shall be such that they can only be fitted or replaced in the correct relationship to their light source.
   c. Reflectors in luminaire bowls shall not deform due to heat from the lamp. Reflectors shall be well secured into position to prevent it from deforming thus causing false photometric performance of the luminaire.

6. Control Gear:

a. Control gear shall be fully housed within the body of the luminaire and be suitable for operation with the specified rating of lamp. Under no circumstances shall control gear be mounted above the lamp or in a position where it may be adversely affected by the heat generated by the lamp.
b. The control gear compartment shall be so designed that there is sufficient space to permit repairs, replacement of components and reassembly without difficultly, without the removal of the luminaire from its mounting.
c. Control gear compartment (containing the ballast, capacitor, ignition devices if applicable, and terminal connectors) shall be sealed by a hinged, lightweight, non-corroding cover and shall be accessible from underneath. No components shall be mounted onto this cover. Access to the gear compartment, via the gear tray cover, shall not be possible without the use of a screwdriver or key, thus protecting unqualified staff, doing lamp replacement, against electric shock.

7. Ballasts:
   a. Shall comply with IEC 60923.
   b. Shall be of the encapsulated or vacuum impregnated type.
   c. Vacuum impregnated ballasts shall be constructed in such a manner that the lamination is engaged within a galvanized steel cover.
   d. Shall only be connected to the primary (line) side of transformer ballasts. After connection of the power factor correction capacitor, the power factor shall not be less than 0.85 (lagging).

8. Capacitors:
   a. Shall comply with IEC 61048 and IEC 61049.
   b. All capacitors shall be fully encapsulated and filled with self-extinguishing resin.

9. Ignition Devices:
   a. Shall comply with IEC 60926 and IEC 60927.
   b. Shall be of the superimposed-pulse solid-state electronic trigger type.
   c. Shall be of the standard type to allow striking of the lamp without switching the power off after replacement of a faulty igniter.
   d. Shall be suitable for operating any make of lamp in conjunction with any make of ballast at temperatures up to 90 °C. The igniter shall be connected in series with the ballast and installed between the ballast and lamp holder.
   e. Shall be suitable for connection in the circuit so that the ignition pulse is confined between the igniter and lamp holder.

10. Internal Wiring:
    a. All Internal wiring of the luminaires shall comply with IEC 60598-2-3.It shall be flexible and suitably rated and insulated to withstand the voltages and temperatures encountered in service.
    b. The neutral conductor of the incoming supply shall be connected to the screw thread portion of Edison screw type lamp holders and the live conductor shall be connected to the central contact and the internal wiring shall be arranged accordingly.
    c. The luminaire shall incorporate a terminal block mounted in a reasonably accessible position as close to the point of entry as possible. The material of the terminal block shall be non-tracking and the terminals shall be made of non-corroding material.

d. Any wiring passing through metal shall have suitable grommets or otherwise protected to avoid abrasion of the insulation.
e. Luminaires shall be earthed in accordance with clause 3.8 of 60598-2-3.
f. All parts of an earth terminal shall be made of brass or similar corrosion-resistant material and the contact surfaces shall be bare metal and not painted or varnished surfaces.
g. All earth connections shall be effected by means of suitable lugs. All possibility of electrolytic corrosion shall be avoided.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the ES, IEC, manufacturer's instructions, and as shown on the drawings or specified.

B. Align, mount, and level the lighting fixtures uniformly.

3.02 ACCEPTANCE CHECKS AND TESTS

A. Perform the following:
1. Visual Inspection:
a. Verify proper operation by operating the lighting controls.
b. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.

2. Electrical tests:
a. Observe for visually detectable flicker and replace defective components.

3.03 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting systems are in good operating condition and properly performing the intended function.

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DIVISION 27 – COMMUNICATIONS

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SECTION 271500

VOICE AND DATA COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Grounding and Bonding for Electrical Systems: Section 260526.

B. Raceway and Boxes for Electrical Systems: Section 260533.

C. Wiring Device: Section 262726.

D. Facility Lightning Protection: Section 264100.

1.02 REFERENCES

A. IEC 11081: Generic communication cabling for premises.

B. IEC 15018: Generic cabling for Small Office and Home Office.

C. IEC 61156: Multicore and symmetrical pair/quad cables for digital comms.

D. IEC 60794: Optical Fiber Cables.

E. ANSI/EIA/TIA 568B: Commercial Building Telecommunications Wiring Standard.

F. ANSI/EIA/TIA 569B: Commercial Building Standard for Telecommunications Pathways and Spaces.

G. ANSI/EIA/TIA 606A: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

H. ANSI/EIA/TIA 607A: Grounding and Bonding Requirements for Telecommunications in Commercial Buildings.

I. ANSI/EIA/TIA 758: Grounding and Bonding Requirements for Telecommunications in Commercial Buildings.

1.03 SUBMITTALS

A. Technical literature and test equipment list:
   1. Equipment technical literature detailing the electrical and other technical characteristics of each item of equipment to be furnished.
   2. List of test equipment.

B. Samples: A sample of each of the following items shall be furnished to the Engineer in Charge for approval prior to installation:
   1. TCO Wall Outlets:
      a. One each telephone (or voice) rj11 jack.

b. Two each multi pin data rj45 jacks.
c. Cover Plate.

2. Quick connect terminal 10/24 Pair.
3. Data patch panel.
4. 1m section of each copper cable to be used.
5. 1m section of each fiber optic cable to be used.

C. Record Wiring Diagrams:
1. Prior to the acceptance test, the Contractor shall deliver two complete sets of the as per built Wiring Diagrams of the System to the Engineer in Charge.

1.04 QUALITY ASSURANCE

A. All materials to be supplied should comply fully to the Standards.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to the job site clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The Engineer in charge may inventory the cable, patch panels, and related equipment.
B. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the Engineer in charge.

PART 2 PRODUCTS

2.01 DISTRIBUTION EQUIPMENT AND SYSTEMS

A. Telecommunication Outlet (TCO):
1. The Telecommunication Outlets (TCO's) shall consist of telephone multipin jack and data multipin jacks.
2. All telephone multipin connections shall be RJ-45/11 compatible female types. All data multipin connections shall be RJ-45 female types.
3. The wall outlet shall be provided with cover plate to fit the telephone multipin jack, data multi- pin jacks.

B. Distribution Cables: Each cable shall meet or exceed specifications for the specific type of cable. Cables installed in any outside location (i.e. above ground, underground in conduit, ducts, pathways, etc.) shall be filled with a waterproofing compound between outside jacket (not immediately touching any provided armor) and inter conductors to seal punctures in the jacket and protect the conductors from moisture.
1. Telephone:
a. The System cable shall be provided by the Contractor to meet the minimum system requirements of Category Six service. The cable shall interconnect each part of the system. The cable shall be completely survivable in areas where it is installed.

Length	As required
Cable	Voice grade category six

Connectors	As required by system design
Size	22 -24 AWG, minimum.
Color coding	Required, telephone industry standard
Bend radius	10X the cable outside diameter
Impedance	120 Ohms ± 15%, BAL
Shield coverage	As required by OEM specification
Attenuation	
Frequency in mHz	dB per 305 M (1,000ft.), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
62.0	52.0
100.0	68.0

2. Technical Characteristics:
   a. Data Multi-Conductor:
   b. The cable shall be multi-conductor, shielded or unshielded cable with stranded conductors. The cable shall be able to handle the power and voltage used over the distance required. It shall meet Category Six service at a minimum.

Wire size	22 AWG, minimum
Working shield	350 V
Bend radius	10X the cable outside diameter
Impedance	100 Ohms ± 15%, BAL
Bandwidth	100 mHz, minimum
DC RESISTANCE	10.0 Ohms/100M, maximum
Shield coverage	
Overall Outside (if OEM specified)	100%
Individual Pairs (if OEM specified)	100%

Attenuation	
Frequency in mHz	dB per 305 M (1,000ft.), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
62.0	52.0
100.0	68.0

3. Fiber Optic:
   a. Multimode Fiber:
      1) The general purpose multimode fiber optic cable shall be a dual window type installed in conduit for all system locations. A load-bearing support braid shall surround the inner tube for strength during cable installation.
      2) Technical Characteristics:

Bend radius	6.0", minimum Outer jacket, As required
FIBER DIAMETER	62.5 MICRONS
Cladding	125 microns
Attenuation	
850 nM	4.0 dB per kM, maximum
1,300 nM	2.0 dB per kM, maximum
Bandwidth	
850 nM	160 mHz, minimum
1,300 nM	500 mHz, minimum
Connectors	Stainless steel

   b. Single mode Fiber:
      1) The general purpose single mode fiber optic cable shall be a dual window type installed in conduit for all system locations. A load-bearing support braid shall surround the inner tube for strength during cable installation.
      2) Technical Characteristics:

Bend radius	100 mm (4 in.) minimum

Outer jacket	PVC
Fiber diameter	8.7 microns
Cladding	125 microns
Attenuation at 850 nM	1.0 dBm per km
Connectors	Stainless Steel

C. System Connectors:
1. Solderless (Forked Connector):
   a. The connector shall have a crimp-on coupling for quick connect/disconnect of wires or cables. The crimp-on connector shall be designed to fit the wire or cable furnished. The connector barrel shall be insulated and color-coded.
   b. Technical Characteristics:

Impedance	As required
Working Voltage	500 V

2. Multipin:
   a. The connector shall have a crimp-on coupling for quick connect/disconnect of wires or cables. The crimp-on connector shall be designed to fit the wire or cable furnished. The connector housing shall be fully enclosed and shielded. It shall be secured to the cable group by screw type compression sleeves.
   b. Technical Characteristics:

Impedance	As required
Working Voltage	500 V
Number of pins	As requires, usually 25 pairs minimum

3. Modular (RJ-45/11 and RJ-45): The connectors shall be commercial types for voice and high speed data transmission applications. The connector shall be compatible with telephone instruments, computer terminals, and other type devices requiring linking through the modular telecommunications outlet to the System. The connector shall be compatible with UTP and STP cables.
4. Fiber Optic: The connectors shall be commercial types for voice and high speed data transmission applications. The connector shall be compatible with telephone instruments, computer terminals, and other type devices requiring linking through the modular telecommunications outlet to the system. The connector shall be compatible with UTP and STP cables.

D. Distribution Frames:
1. A stand-alone (i.e., self-supporting, free standing) MDF shall be provided. The MDF shall be modular and equipped with modular terminating mini blocks and patch panels which provide all the requirements.
2. Stand alone or wall mounted racks shall be provided for Intermediate Telecommunication Closet (IMTC) and Floor Telecommunication Closet (FTC) and the sizes will be determined according to the requirements at each level.
3. All cable distribution closets and MDFs shall be wired in accordance with industry standards and shall employ "latest state-of-the-art" modular cross-connect devices.

The MDF/telephone closet riser cable shall be sized to satisfy all voice requirements plus not less than 50% spare (growth) capacity in each telephone closet which includes a fiber optic backbone. The MDF/telephone closet riser cable shall be sized to satisfy all voice and data requirements plus not less than 50% spare (growth) capacity in each telephone closet which does not include a fiber optic backbone.

4. Technical Characteristics:

Telephone	Insulation Displacement Connector (IDC) type unit
Contact wires	50 micron of Gold over Nickel
Contact pressure	100 Grams, MIN
110A Punch blocks	Acceptable alternate to Insulation Displacement Connector (IDC)
Data	110A blocks
Fiber optic	Fiber Optic Patch panel

2.02 RACEWAYS

A. (Refer Section 2760533) Raceways and Boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. System Installation:
   1. After the contract's been awarded, and within the time period specified in the contract, the Contractor shall deliver the total system in a manner that fully complies with the requirements of this specification. The Contractor shall make no substitutions or changes in the System without written approval from the Engineer in Charge.
   2. The Contractor shall install all equipment and systems in a manner that complies with accepted industry standards of good practice, OEM instructions, the requirements of this specification, and in a manner which does not constitute a safety hazard. The Contractor shall insure that all installation personnel understands and complies with all the requirements of this specification.
   3. All lines shall be terminated in a suitable manner to facilitate future expansion of the System.
   4. Equipment installed outdoors shall be weatherproof or installed in weatherproof enclosures with hinged doors and locks with two keys.

B. Raceway and boxes installation:
   1. Refer Section 260533 Raceways and Boxes.

C. Distribution system wires and cables:
   1. Termination:
      a. Each wire and cable shall terminate on an item of equipment by direct connection.
      b. Fiber optic cables that are spare, unused or dark shall be provided with Industry Standard "ST" type female connectors installed in appropriate break out, patch,

or bulkhead connector panels provided in enclosure(s) and shall be protected from the environment.

c. All cable junctions and taps shall be accessible.

2. Routing and Interconnection:
   a. Wires or cables between consoles, cabinets, racks and other equipment shall be in an approved conduit, cable duct, or cable tray that is secured to building structure.
   b. Wires and cables shall be insulated to prevent contact with signal or current carrying conductors. Wires or cables used in assembling consoles, panels, equipment cabinets and racks shall be formed into harnesses that are bundled and tied. Harnessed wires or cables shall be combed straight, formed and dressed in either a vertical or horizontal relationship to equipment, controls, components or terminations.
   c. Harnesses with intertwined members are not acceptable. Each wire or cable that breaks out from a harness for connection or termination shall have been tied off at that harness or bundle point, and be provided with a neatly formed service loop.
   d. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right. This installation shall be accomplished with ties and/or fasteners that will not damage or distort the wires or cables. Limit spacing between tied off points to a maximum of 150 mm (6 inches).
   e. Do not pull wire or cable through any box, fitting or enclosure where change of cable tray or signal or cable duct alignment or direction occurs. Ensure the proper bend radius is maintained for each wire or cable as specified by its OEM.
   f. Cables shall be labeled with permanent markers at the terminals of the electronic and passive equipment and at each junction point in the System. The lettering on the cables shall correspond with the lettering on the record diagrams.
   g. Completely test all of the cables after installation and replace any defective cables.
   h. Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra violet protection and be totally waterproof (including all connections). The laying of wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.
   i. Wires or cables installed in underground conduit, duct, etc.:
      1) Wires or cables installed in underground installations shall be waterproofed by the inclusion of a water protective barrier (i.e. gel, magma, etc.) or flooding compound between the outside jacket and first shield. Each underground connection shall be accessible in a manhole, recessed ground level junction box, above ground pedestal, etc., and shall be provided with appropriate waterproof connectors to match the cable being installed.

2) Warning tape shall be continuously placed 300 mm (12 inches) above buried conduit, cable, etc.

3. Outlets:
   a. Install Outlets as per the drawings and bill of quantities and as per specifications herein.
   b. Use suitable tools to install/connect outlets.

4. Connection in Fast Connect blocks and patch panels:
   a. Use the appropriate tools to make connections in quick connect blocks and patch panels.

5. Grounding and surge protection:
   a. General: The Contractor shall ground all Contractor Installed Equipment to eliminate all shock hazards and to minimize, to the maximum extent possible, all ground loops, common mode returns, noise pickup, crosstalk, etc.
   b. Equipment: Equipment shall be bonded to the cabinet bus with copper braid equivalent to at least 2.5mmsq wire. Self-grounding equipment enclosures, racks or cabinets, that provide OEM certified functional ground connections through physical contact with installed equipment, are acceptable alternates.
   c. Cable Shields: Cable shields shall be bonded to the cabinet ground bus with 2.5 sq. mm minimum stranded copper wire. Cable shields shall be insulated from each other, faceplates, equipment racks, consoles, enclosures or cabinets; except, at the system common ground point. Coaxial and audio cables, shall have one ground connection at the source; in all cases, cable shield ground connections shall be kept to a minimum.

D. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for voice and data circuits shall be stenciled using printers. Handwritten labels are not acceptable.
   1. Cable and Wires (Hereinafter referred to as “Cable”): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System “Record Wiring Diagrams”.
   2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or Bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
   3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit (Surface mounted conduits), duct and tray, with permanent marking devices. In addition, each enclosure shall be labeled.
   4. Termination Hardware: The Contractor shall label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A.

3.02 FIELD QUALITY CONTROL

A. Interim Inspection:
   1. This inspection shall verify that the equipment provided adheres to the installation requirements of this document. Each item of installed equipment shall be checked. This inspection shall verify cabling terminations in telecommunications rooms and at workstations adhere to color code for T568B pin assignments and cabling

connections are in compliance with ANSI/EIA/TIA standards. Visually confirm Category 6 marking of outlets, faceplates, outlet/connectors and patch cords.

2. Perform fiber optical field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.
3. The Contractor shall notify the Engineer's Representative, in writing, of the estimated date the Contractor expects to be ready for the interim inspection, before the requested inspection date.
4. Results of the interim inspection shall be provided to the Engineer's Representative. If major or multiple deficiencies are discovered, a second interim inspection may be required before permitting the Contractor to continue with the system installation.
5. The Engineer's Representative shall determine if an additional inspection is required, or if the Contractor will be allowed to proceed with the installation.

B. Pretesting:
   1. Upon completing the installation of the System the Contractor shall pretest the entire system.
   2. Pretesting Procedure:
      a. During the system pretest, the Contractor shall verify (utilizing the approved spectrum analyzer and test equipment) that the System is fully operational and meets all the system performance requirements of this standard.
      b. The Contractor shall pretest and verify that all System functions and specification requirements are met and operational, no unwanted aural effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise, etc. are present.

   3. The Contractor shall provide pretest measurements and the written certification that the System is ready for the formal acceptance test shall be submitted to the Engineer in Charge.

C. Acceptance Test: After the System has been pretested and the Contractor has submitted the pretest results and certification to the Engineer in Charge, then the Contractor shall schedule an acceptance test date and give the Engineer's Representative written notice prior to the date the acceptance test is expected to begin. The System shall be tested utilizing the approved test equipment to certify proof of performance and Life Safety compliance. The test shall verify that the total System meets the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.

D. Performance Testing:
   1. Perform Category 6 tests in accordance with ANSI/EIA/TIA-568-B.1 and ANSI/EIA/TIA-568-B.2. Test shall include the following: wire map, length, insertion loss, return loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, propagation delay and delay skew.
   2. Fiber Optic Links: Perform end-to-end fiber optic cable link tests in accordance with ANSI/EIA/TIA-568-B.3.

E. Total System Acceptance Test: The Contractor shall perform verification tests for all communication cabling system(s) after the complete telecommunication distribution system and workstation outlet are installed.

1. Voice Testing: Connect to the network interface device at the demarcation point. Go off-hook and receive dial tone from the LEC. If a test number is available, place and receive a local, long distance, and FTS telephone call.
2. Data Testing: Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network is achieved.

3.03 TRAINING

A. Provide training to designated Facility personnel. Instruction shall include cross connection, corrective, and preventive maintenance of the System and equipment.
B. Before the System can be accepted, this training must be accomplished. Training will be scheduled at the convenience of the Procuring Entity.

3.04 GUARANTEE PERIOD OF SERVICE

A. Contractor's Responsibilities:
   1. The Contractor shall guarantee that all installed material and equipment will be free from defects, workmanship, and will remain so for a period of one year from date of final acceptance of the System. The Contractor shall provide OEM's equipment warranty documents, to the Engineer's Representative and Procuring Entity if the Facility has taken procession of the building(s)), that certifies each item of equipment installed conforms to published specifications.
   2. The Contractor shall provide the Engineer's Representative a type written report itemizing each deficiency found and the corrective action performed during the period from the provisional acceptance to final acceptance. The Contractor shall provide the Engineer's Representative with sample copies of these reports for review and approval at the beginning of the Total System Acceptance Test.

END OF SECTION

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

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SECTION 283100

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 REFERENCES

A. ES 1567: Cable Performance Requirements for Cables Required to Maintain Circuit Integrity under Fire Conditions.

B. ES ISO 7240-1: Fire Detection and Alarm System, General and Definitions.

C. ES 1522: Fire Detection and Alarm System for Buildings. Code of Practice for System Design, Installation, Commissioning and Maintenance.

D. EN 54: Fire Detection and Fire Alarm Systems.

E. IEC 60331-2: Tests for Electrical Cables under Fire Conditions.

F. BS 8519: Selection and Installation of Fire Resistant Power and Control Cable Systems for Fire Safety and Firefighting Applications. Code of Practice.

G. IEC 61034 - 2005: Measurement of Smoke Density of Cables Burning under Defined Conditions.

H. IEC 60754 - 2011: Test on Gases Evolved During Combustion of Materials from Cables.

1.02 SUBMITTALS

A. Product data: Detection and alarm system submittals shall include, as a minimum, the following information and data:
   1. Product catalogue of all system components including quality approval and standard compliance certificates.
   2. Complete system wiring diagrams.

B. Testing program:
   1. The completed fire alarm system shall be fully tested in accordance with ES 1522 and EN54 under the observation of the Engineer and subject to approval by the Fire Authority.

C. Test Reports:
   1. Submit results of electrical continuity, insulation, and ground continuity tests performed on installed wiring.

D. Operation and maintenance manual:
   1. Submit operation and maintenance data.

E. Fire safety compliance body (if applicable)*:*

1. Separate Drawings of the fire alarm and detection system shall be submitted to the Fire Safety Compliance body/authority for approval. Approval shall be obtained before beginning installation work.

1.03 QUALITY ASSURANCE

A. Each and all items of the fire alarm system should be product of a single fire alarm system manufacturer with approval for its compliance to the relevant standards.

1.04 SITE CONDITIONS

A. Inspect surfaces and structures to, and on which products will be installed before the work of this Section begins. Provide surfaces and structures capable of supporting the products. Surfaces that will be concealed by products shall be finished before products are installed.

PART 2 PRODUCTS

2.01 FIRE ALARM SYSTEM

A. Furnish and install a complete fire alarm system as indicated. The system shall be wired, connected, and left in operating condition. The system shall be electrically supervised. Provide a control panel, manual Break Glass Push Buttons, smoke and heat detectors, annunciator and indicators, all wiring, connections to devices, outlet boxes, junction boxes, and all other material and accessories as necessary for a complete operating system.

B. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.

2.02 EQUIPMENT

A. Fire Alarm Control Panel (FACP):
   1. The fire alarm control panel shall be modular and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: repeater panels, smoke and thermal (heat) detectors, manual push buttons, visual and sound alarm devices and other system controlled devices.
   2. The software shall be such so as to be easily operated by the Client’s Personnel and secured against Software errors, ability to be upgraded so as to incorporate more features at a later date.
   3. The fire alarm control panel shall meet the requirements of EN 54-2.
   4. The System shall be fail safe and adequate safe guards should be under taken that in the event of a failure of a part of the System it shall not handicap the complete System. The logic circuitry shall be based on high noise immunity solid state hardware.
   5. The FACP shall be able to analyze all inputs from all zones/addressable units, and through its own software and ambient level screening the FACP shall be able to identify fire, possible fire or fault conditions. The unit supervision shall be dynamic and continuous.
   6. Alarm priority: The FACP shall also be able to discriminate between false alarms and fire conditions, as well as priority selection of alarm in case alarm activates in two or more

remotely located units simultaneously. In such cases, the Manual Call Points shall have the highest priority.

7. The FACP shall have its own Battery Backup of a minimum of 24 hours in normal run and then half an hour in alarm condition. The Battery shall be of sealed lead acid re-chargeable maintenance free type.
8. The FACP shall also capable of repeating all the events & messages to an Active Repeater Panel if required.
9. The fire alarm control panel shall include a full-featured operator interface control for the field programming and control of the fire alarm system. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
10. Display: The backlit Large LCD display shall be a minimum of 4-line (160 characters) for displaying system messages, information associated with the fire alarm condition, including the type of alarm zone/point and its location within the protected premises. Also shall provide programming menus along with buttons.
11. LED Indicators: It shall provide Light-Emitting-Diodes (LEDs) that indicate the status of the following minimum system parameters: POWER STATUS, TEST STATUS, FIRE ALARM, FAULT, CPU FAILURE, POINTS DISABLED etc.
12. Alarm Acknowledge: Activation of the control panel acknowledges function in response to new alarms and/or troubles shall silence the local panel buzzer and the associated LED on the panel shall be turned ON.
13. Signal Silence: Signal Silence function shall cause all programmed alarm notification appliances to return to the normal condition.
14. System Reset: System Reset switch shall cause all electronically latched initiating devices to return to their normal condition.

B. Manual Break Glass Push Buttons:
   1. Manual call stations shall be wall structure mounting break-the-glass type. The unit shall be addressable and communicate with the FAP like other detectors if so specified. The glass shall be marked, "In case of fire break glass." Manual call points for outdoor mounting shall have IP-65 enclosure protection and in explosion hazardous areas shall have explosion proof protection. The explosion proof-ness shall be certified by recognized approval body.

C. Detectors:
   1. General: All detectors should be base compatible and should also be addressable if so specified in the bill of quantities.
   2. Smoke detectors:
      a. Photoelectric type smoke detectors: Should be designed for early response to slow burning, smoldering fires, operating on light scatter principles sensor, should meets the sensitivity requirements of EN 54 Part 7.
      b. Ionization smoke detectors: Should be designed to provide r reliable sensing of both visible and invisible products of combustion from fast burning fires. The sensors advanced design and proven response make it effective in risk areas where materials such as oil, spirits, wood or paper may be stored Should fully meet the sensitivity requirements of European Standard, EN 54 Part 7.

   3. Heat Detectors:
      a. Heat Detector Rate of Rise type: Should be designed on advanced thermistor technology and provide a reliable response to fires in areas where environmental conditions prohibit the use of smoke detection and operate on

the rate of rise of its ambient temperature. And should meets the requirements of EN 54 Part 5.

b. Heat Detector, Fixed Temperature type: Should be designed on Advanced thermistor technology and provide a reliable response to fires in locations where fluctuations of ambient temperature may be expected. It should meet the requirements of EN 54 Part 5.

D. Visual indicators: shall start flashing when the detector in that particular zone has been activated due to smoke or fire. During normal polling the LED shall blink at a lesser rate same as that of detector. The LED's of the response indicators shall be housed on aesthetically designed PVC/ FRP bases. Device should comply with EN 54 Part 23.

E. Alarm sounder: An Alarm Sounder may be a bell or electronic sounder. A minimum sound level of either 65db(A) or 5db(A) above any background noise likely to persist for longer than 30 seconds, whichever is the greater, should be produced by the sounders at any point in the building. If the alarm system is used in premises such as hotels, boarding houses etc. where the alarm is intended to wake sleeping persons then the sound level at the bedhead should be at least 75db(A) with all doors closed. The hooters required for outdoor mounting shall have rain canopy for protection from rainwater and direct sun. Device shall comply with EN 54 Part 24.

F. Repeater panel: Repeater Panel shall duplicate all the audio-visual annunciation initiated at the main panel. The display and control functions provided at repeater shall be same as that of Main panel. The unit shall be aesthetically designed, suitable for wall / structure mounting. The unit shall be designed for power supply and operating conditions, same as that of Main panel and comply with EN 54 part 2.

G. Fire detection and alarm system cable:
1. The fire alarm cables shall be fire rated to maintain the integrity of the Fire Alarm Circuits under the fire conditions complying with IEC 60331.
2. Shall be Flame and Fire Retardant complying with IEC 60332-1 and IEC 60332-3.
3. Shall be halogen free with low smoke emission complying with IEC 61034-2 and low toxicity complying with IEC 60754-2.
4. Screened cables are recommended for addressable systems to avoid interference with other systems.

PART 3 EXECUTION

3.01 INSTALLATION

A. Control and detection devices, equipment, and outlets shall be located to avoid interference with mechanical, architectural, and structural features.

B. Wiring:
1. As far as possible, joints should be avoided except where a joint is inside one of the systems components i.e.: Control Panel, detector, Call Point, Sounder etc. Where joints are required elsewhere they should be enclosed in a suitable junction box marked fire alarm to ensure that the fire alarm systems is not accidentally interfered with.
2. Fire alarm cables, should always be segregated from cables for other systems. Installation of cables should be in accordance with good practices recommended in

the latest edition of the wiring regulations. Connection to the mains supply should be via an isolating switch fuse reserved solely for the purpose. Its cover must be painted red and labelled “Fire Alarm - do not switch off”.

3. Conductor size should take voltage drop into account. In any case conductors should have a cross sectional area of not less than 1 square millimeter.
4. Where possible cables should be routed through areas of low fire risk. Cables installed in damp, corrosive or underground locations should be PVC sheathed and where there is a risk of mechanical damage should be protected accordingly. If Cables are installed less than 2.25m above the floor they should be protected.

C. Fire alarm control panel:
   1. The Fire Alarm Control Equipment should be sited preferably in an area of low fire risk and on the ground floor by the entrance used by the Fire Brigade and preferably viewable from outside of the building. It should be located in an area common to all building users and where automatic detection is in use, the Control Panel should be in a protected area.
   2. A suitable zone chart of the building should normally be installed adjacent to the Control Panel.

D. Detectors:
   1. Smoke detectors: Smoke Detectors should be sited so that the sensing element is not less than 25mm, nor more than 600mm below the ceiling or roof.
   2. Heat Detectors: Heat Detectors should be sited so that the heat sensitive element is not less than 25mm, nor more than 150mm below the ceiling or the roof.

E. Break glass push buttons: They should be mounted 1.4m from the floor and sited where they can be easily seen.

F. Sounder and visual alarm devices: The sounder and visual alarm devices should be installed above the manual call point at 2.2 to 2.4 m from the floor.

3.02 QUALITY CONTROL

A. Testing:
   1. The system shall be completely tested prior to final acceptance. All points shall be tested from point of initiation to the final point or points of annunciation. All circuits shall be tested for continuity and ability to transmit the required signal correctly to the FACP. Any problem due to wrong wire type, wire twist, impedance mismatches, noise filtering, or shielding shall be corrected. Testing shall include every device in the system. Coordinate with other trades as necessary for testing.

3.02 TRAINING SESSIONS

A. Provide training sessions in the operation and maintenance of the fire detection and alarm systems for maintenance personnel prior to acceptance of the installed systems. Training sessions shall be conducted by a representative of the fire detection and alarm system's manufacturer or supplier. The training sessions shall enable a qualified service technician to troubleshoot and maintain the system.

B. The Contractor shall schedule the training sessions**.** The sessions shall include the following training:

1. Classroom-type training, giving course participants an understanding of the overall system and its operation.
2. Hands-on training, giving course participants actual trouble-shooting and maintenance experience. This shall include training in user-level programming of the FACP to perform routine maintenance tasks such as deleting a device or zone, or reprogramming the FACP to recognize a substitute or replacement device.

C. Provide professionally prepared training manuals to supplement the Operation and Maintenance Manuals.

END OF SECTION

DIVISION 31 – EARTHWORK

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Ministry of Construction

SECTION 310000

EARTHWORK

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Site Clearing: Section 311000.

1.02 REFERENCES

A. EBSC EN 1997:2015: Geotechnical Design.

B. ES 1648: Workmanship on Building Sites. Code of Practice for Excavation and Filling.

C. ES 1529: Code of practice for Site Investigations.

D. BS 6031: Code of Practices for Earthworks.

E. BS 812: Testing Aggregates.

F. BS 6100:2.2.1: Glossary of Building and Civil Engineering Terms – Part 2. Civil Engineering – Section 2.2 Substructures. Earthworks. Foundations. Tunnels – Section 2.2.1 Earthworks.

G. ASTM D 1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 KN-m/m3).

H. ASTM D 3398: Standard Test Method for Index of Aggregate Particle Shape and Texture.

I. AASHTO T 27: Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.

J. AASHTO T 180: Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

K. AASHTO T 193: Standard Method of Test for the California Bearing Ratio.

1.03 DEFINITIONS

A. Except as indicated otherwise specified in the Contract Documents, all the terms in this section shall comply with the definition stated in BS 6100:2.2.1 including the following:
   1. Earthwork: Work of excavating or raising of ground.
   2. Excavation: Result of digging, lifting and removing of earth, fill or other materials from the ground.
   3. Retaining wall: Wall that provides lateral support to the ground or to resist pressure from a mass of other material.
   4. Drainage: Removal of surplus water.
   5. Dewatering: Procedure to lower the level of ground water locally.

6. Topsoil: Surface layer of soil given fertility by the action of living organisms and the presence of organic matter.
7. Subsoil: Soil immediately below topsoil.
8. Sub-grade Surface: Surface upon which sub-base or topsoil is placed.
9. Sub-base: Select granular material or sub-base course which is placed immediately beneath pavement or concrete slabs.
10. Road Base: A layer of material of defined thickness and width constructed on top of the sub-base, or in the absence thereof, the sub-grade. A road base may extend beyond the carriageway.
11. Rip-rap: Un-bonded stone provided to protect the surfaces of slopes and the beds of watercourses from erosion and scour.
12. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
13. Landscaped Areas: Areas not covered by structures, walks, roads, paving, or parking.
14. Unauthorized Excavation: The removal of material below required elevation indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Engineer's Representative.

B. Description of soils and rocks: A comprehensive system for the description of soils and rocks is given in ES 1529 and shall be complied including the following:
1. Soil: Mineral material that results from the weathering of rock.
2. Rock: Relatively hard naturally occurring part of the earth's crust that has not been broken down into loose material that can be readily excavated by hand.
3. Boulder: Rounded fragment of rock, usually large (more than 256 mm).

1.04 SUBMITTALS

A. Shop Drawings:
1. Sheeting, Shoring, and Bracing (Shown on the Drawings): Submit shop drawings for sheeting, shoring, and bracing shown on the Drawings.

B. Product Data:
1. Permanent Sheeting, Shoring, and Bracing: Specifications for materials and accessories.
2. Filter Fabric: Manufacturer's catalog sheets, specifications, and installation instructions.

C. Samples: Submit samples as follows. Take the samples in the presence of the Engineer's Representative, and submit to the Engineer's Representative the laboratory test results for gradation, proctors and soundness tests, when required. These tests will be performed in accordance with referenced standards, will be performed and signed by a certified soils laboratory, and will be submitted as part of the original submittal. At a minimum the samples taken will be of the following quantities:
1. Select Granular Material: 50 - 60 kg. (Two Samples).
2. Sub-base Course Type 2: 50 - 60 kg. (Two Samples).
3. Selected Fill: 40 - 50 kg.
4. Cushion Material: 30 kg.
5. Under-drain Filter Material: 40 - 50 kg.
6. Crushed Stone, Crushed Gravel, or Screened Gravel (Wastewater): 30 kg., each layer gradation (if more than one).

7. Sand Filter Material (Wastewater): 30 kg.

D. Quality Control Submittals:
   1. Sub-base Materials: Name and location of source and the results of the gradation and soundness tests performed by certified soils laboratory will be required.
   2. Other Aggregates: Name and location of source and soil laboratory test results.
   3. Excavation Procedure: Submit a lay out drawing or detailed outline of intended excavation procedure for the Engineer's information. This submittal will not relieve the Contractor of responsibility for the successful performance of intended excavation methods.
   4. Sheeting, Shoring, and Bracing (Not shown on the Drawings): Submit a detailed plan of intended sheeting, shoring and bracing for the Engineer's information. This submittal will not relieve the Contractor of responsibility for the successful performance of the intended sheeting, shoring and bracing methods.
   5. Qualification of Workmen: Operators of equipment and men guiding laborers shall be skilled workmen thoroughly trained and experienced in this trade. At least one person thoroughly familiar with the specified requirements of the work described in this section shall be in charge.

1.05 QUALITY ASSURANCE

A. Workmanship on building site: Comply with the requirements of ES 1648.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect filter fabric from sunlight during transportation and storage.

1.07 PROJECT CONDITIONS

A. Protect existing trees and plants during performance of the Work unless otherwise indicated. Box trees and plants indicated to remain within the grading limit line with temporary steel fencing or solidly constructed wood barricades as required. Protect root systems from smothering. Do not store excavated material, or allow vehicular traffic or parking within the branch drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.

B. Cold Weather Requirements:
   1. Excavation: When freezing temperatures are anticipated, do not excavate to final required elevations for concrete work unless concrete can be placed immediately.
   2. Backfilling: Do not use frozen materials for filling excavations and do not place fill materials on frozen ground.
      a. Frozen ground will be removed in its entirety from beneath and beyond the area of fill placement.
      b. The fill material placed will consist of Selected Fill and will be free of all frozen chunks. The material transported to the project site will only consist of material excavated from below the frost depth.

C. Thru-traffic or fill placement with heavy construction vehicles or equipment which causes rutting or weaving to occur within the perimeter of a building will not be permitted. If rutting or weaving occurs during placement of fill, place specified fill in a stable area outside building perimeter and spread with tracked equipment to specified layer thickness.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. Use suitable materials for fill Works in the project site.
    a. Provide borrow fill material when sufficient satisfactory fill materials are not available from excavations.
    b. Do not use the following materials under any circumstances for forming load bearing fills;
        1) Organic soils, e.g. peat and some alluvial clays and silts.
        2) Toxic materials, e.g. industrial waste containing soluble compounds harmful to waste supply or agriculture.
        3) Material containing compounds harmful to other elements of construction, e.g. rejects from gypsum mining which can contain a high concentration of soluble Sulphate harmful to concrete.
        4) Materials containing substances which can be dissolved or leached or which may undergo expansive reactions in the presence of moisture, e.g. pyritic shale.
        5) Materials when they are in a frozen condition.

2. Suitable fill materials: Unless indicated otherwise in the Contract Documents, suitable materials for use as fill in the project site shall comply with the gradation and other requirements of EBSC EN 1997:2015, applicable Referenced Standards and as specified in this Section including the following.
    a. Materials of high shear strength unaffected by changes in moisture content, e.g. strong durable rocks, gravel, medium and coarse sands, is suitable as a fill under any circumstances.
    b. Californian Bearing Ratio (CBR): The fill material shall have a minimum soaked Californian Bearing Ratio (CBR) of not less than 4% and a swell value of not more than 1.5% (with two surcharge rings) when determined in accordance with AASHTO T-193.
        1) The Californian Bearing Ratio (CBR) shall be determined at a density of 95% of the maximum dry density determined in accordance with the requirements of AASHTO T-180 method D.

    c. Liquid Limit and Plasticity Index: The fill material shall have a liquid limit not exceeding 60% and a plasticity index not exceeding 30 when determined in accordance with the requirements of AASHTO T-89 and T- 90.
    d. Maximum Particle Size: The fill material shall not contain particles with a maximum dimension exceeding two-thirds of the specified layer thickness after compaction, except in the case of rock fill.

B. Sub-base course in general:
1. The materials used for the construction of sub-base layers shall be natural gravel, scoria (cinder gravel), weathered rock, crushed gravel, crushed rock or crushed boulders, recycled pavement material or any other granular material complying with the requirements of applicable Referenced Standards.

C. Gravel sub-base: Gravel material to be used for sub-base shall be obtained from approved sources in borrow areas, cuts or existing pavement layers. The complete sub-base shall contain no material having a maximum dimension exceeding two-thirds of the completed layer thickness. Gravel Sub-base material shall, unless otherwise stated, conform to the following requirements.
   1. Grading limits: Comply with one of the grading requirements shown in table 1 as described in the Contract Documents. The material shall have a smooth continuous grading within the limits for grading A, B or C given in in table 1.

Table 1: Grading Requirements for Sub-base Material:

Sieve Size (mm)	Mass Percent Passing			
	A	B	C	D
63.0	100	-		-
50.0	90 - 100	100	100	-
37.5			80-100	
25.0	51 - 80	55 - 85		100
20			60-100	
9.5	-	40 - 70		51 - 85
5			30-100	
4.75	35 - 70	30 - 60		35 - 65
2.0	-	20 - 51		25 - 51
1.18			17-75	
0.425	-	10 - 30		15 - 30
0.3			9-50	
0.075	5 - 15	5 - 15	5-25	5 - 15

   2. The complete sub-base shall contain no material having a maximum dimension exceeding two-thirds of the compacted layer thickness.
   3. Sub-base material shall, unless otherwise authorized, conform to the following requirements when finally placed.
   4. Grading Modulus: The minimum Grading Modulus shall be 1.5 except where a material, having a lower Grading Modulus but not less than 1.2, is approved for use by the Engineer.
   5. Plasticity Index: All sub-base materials shall have a maximum Plasticity Index of 6 or 12, as described in the Contract, and when determined in accordance with AASHTO T-90. The plasticity product (PP = PI x percentage passing the 0.075mm sieve) shall not be greater than 75.
   6. Californian Bearing Ratio (CBR): The minimum soaked Californian Bearing Ratio (CBR) shall be 30% when determined in accordance with the requirements of AASHTO T-193. The Californian Bearing Ratio (CBR) shall be determined at a density of 95% of the maximum dry density when determined in accordance with the requirements of AASHTO T-180 method D.
   7. Compaction requirements: The minimum in- situ dry density of sub-base material shall be as specified hereinafter for the layers in terms of a percentage of modified AASHTO density:
      a. 95% or 97% as required for material not chemically stabilized.
      b. 95% or 96 % as required for chemically stabilized material.

   8. Los Angeles Abrasion:
      a. The Los Angeles abrasion value shall not exceed 51% when determined in accordance with the requirements of AASHTO T-96.

D. Crushed stone sub-base: The aggregate used for crushed stone sub-base shall be derived from a parent rock that is hard, sound, durable, and un-weathered. It shall be obtained from sound rock from an approved quarry or clean sound boulders. It shall contain no deleterious material such as decomposed rock, clay, shale, or mica. The crushed aggregate shall comply with the following requirements:

1. Grading limits: The grading of the crushed stone sub-base shall comply with one of the grading requirements shown in table 2 as described in the Contract, or as approved or directed by the Engineer. The grading shall follow a smooth curve without any marked gaps or excessive quantities at a particular size, unless specified otherwise.

Table 2: Grading Requirements for Crushed Stone Sub-base Material:

Sieve Size (mm)	**Percentage Passing by weight**		
	A	B	C
	Nominal size 37.5 mm	Nominal size 28 mm	Nominal size 20 mm
50.0	100		
37.5	95-100	100	
28			100
20	60-80	70-85	90-100
10	40-60	50-65	60-75
5	25-40	35-55	40-60
2.36	15-30	25-40	30-45
0.425	7-19	12-24	13-27
0.075	5 - 12	5 - 12	5 - 12

a. Tests to determine whether the crushed stone material complies with the specified grading requirements shall be conducted after the material has been mixed on the road and spread out.

b. The aggregate shall be produced entirely by the crushing of rock or boulders. Single stage crushing will not be allowed and the crusher installation shall be capable of producing material complying with the specified requirements. If, however, the nature of the parent rock is such that despite every effort made the material remains deficient in the finer fractions, the Engineer may allow the addition of approved soil fines, crusher fines or sand in controlled quantities not exceeding 15% by mass of the aggregate. Fines shall be introduced at the crushing plant.

2. Grading Modulus: The minimum Grading Modulus shall be 1.5 except where a material, having a lower Grading Modulus but not less than 1.2, is approved for use by the Engineer.
3. Plasticity Index (PI): The Plasticity Index shall not exceed 6.
4. Compaction Requirements: The minimum dry density to which the material shall be compacted shall be 95% unless specified otherwise, shown on the drawings or ordered by the Engineer, of the maximum dry density as determined by AASHTO T 180. Field dry densities shall be determined by the sand replacement method as specified in AASHTO T 191 or nuclear method as specified in AASHTO T 238.
5. Los Angeles Abrasion: The Los Angeles abrasion value shall not exceed 45% when determined in accordance with the requirements of AASHTO T-96.

6. Particle shape: Flakiness Index: The flakiness index, determined by testing in accordance with BS 812, Part 105 or ASTM D 3398, shall not exceed 35.
    a. The crushed aggregate portion, which is retained on the 5 mm sieve, shall have at least 75 percent by weight of particles with at least two fractured faces and 100 percent with at least one fractured face. The area of each face shall be equal to at least 75 percent of the smallest midsection area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

E. Road base: Road base shall be approved quality materials of crushed, screened or crushed and screened stones or gravels, natural gravels, and stabilized base materials. The road base layer shall be constructed to the dimensions and cross sectional profiles shown in the Contract Drawings. The materials used for the construction of road base layers shall be Crushed Rock or Stone, or Naturally occurring Granular Materials, Boulders, Weathered Rock, as described in the Contract:
    1. Crushed Rock or Stone: This material is produced by crushing fresh, quarried rock (Graded crushed stone) and may be an all-in product, usually termed a 'crusher-run', or alternatively the material may be separated by screening and recombined to produce a desired particle size distribution, as per the specifications. The material shall be clean and free from organic matter, lumps of clay or other deleterious substances. The material shall be of such a nature that it can be readily transported, spread and compacted without segregation.
        a. Grading: The combined grading of the material shall be a smooth continuous curve falling within the grading limits shown in Table 3 when determined in accordance with the requirements of AASHTO T-27. The mass of material passing the 0.075mm sieve shall be determined in accordance with the requirements of AASHTO T-11.

Table 3: Grading Limits for Graded Crushed Stone Base Course Materials (Graded crushed stone)

Test sieve (mm)	Percentage by mass of total aggregate passing test sieve		
	Nominal maximum particle size		
	37.5 mm	28 mm	20 mm
50	100	-	-
37.5	95 – 100	100	-
28	-	-	100
20	60 – 80	70 - 85	90 – 100
10	40 – 60	50 - 65	60 – 75
5	25 - 40	35 - 55	40 – 60
2.36	15 – 30	25 - 40	30 – 45
0.425	7 – 19	12 - 24	13 – 27
0.075(1)	5 – 12	5 – 12	5 – 12

Note (1): For paver-laid materials a lower fine content may be accepted.

    b. Plasticity Index: The fine fraction of a Graded crushed stone material shall be non-plastic or shall have a maximum Plasticity Index of 6 when determined in accordance with AASHTO T-90.
    c. Californian Bearing Ratio (CBR): The in- situ dry density of the placed material should be a minimum of 98% of the maximum dry density obtained in the ASTM Test Method D 1557 (Heavy Compaction). The compacted thickness of each layer should not exceed 200 mm.

1) Crushed stone base courses constructed with proper care with Graded crushed stone materials described above should have CBR values in excess of 100 per cent.

d. Aggregate Crushing Value (ACV): Requirements expressed in terms of the results of the Aggregate Crushing Value (ACV) (British Standard 812, Part 110) may be used: the ACV should preferably be less than 25 and in any case less than 29.
   1) Other simpler tests e.g. the Aggregate Impact Test (British Standard 812, Part 112, 1990) may be used in quality control testing provided a relationship between the results of the chosen test and the Ten percent Fines Value (TFV) has been determined.

e. Mechanical Strength Requirements (TFVT): To ensure that the materials are sufficiently durable, they should satisfy the criteria given in Table 4. These are a minimum Ten Per Cent Fines Value (TFV) (British Standard 812, Part 111) and limits on the maximum loss in strength following a period of 24 hours of soaking in water. The likely moisture conditions in the pavement are taken into account in broad terms based on annual rainfall.

Table 4: Mechanical Strength Requirements for the Aggregate Fraction of Crushed Stone Base Course Materials (GB1) as Defined by the Ten Percent Fines Test

Typical Annual Rainfall (mm)	Minimum 10% Fines Values (KN)	Minimum Ratio Wet/Dry Test (%)
>500	110	75
<500	110	60

f. Flakiness Index: The flakiness index shall not exceed 30% when determined in accordance with BS 812 Part 105-1990.

2. Naturally occurring Granular Materials, Boulders, Weathered Rock: Graded Natural Gravel: A wide range of materials including lateritic, calcareous and quartzitic gravels, river gravels, boulders and other transported gravels, or granular materials resulting from the weathering of rocks can be used successfully as base course materials. The material shall be of such a nature that it can be readily transported, spread and compacted without segregation.
   a. Grading: The particle size distribution should be approximately parallel with the grading envelope, to ensure that the material has maximum mechanical stability, in the grading limits shown in Table 5 when determined in accordance with the requirements of AASHTO T-27. The mass of material passing the 0.075mm sieve shall be determined in accordance with the requirements of AASHTO T-11. Table 5 contains two recommended particle size distributions for suitable materials corresponding to maximum nominal sizes of 37.5 mm and 20 mm.

Table 5: Recommended Particle Size Distributions for Mechanically Stable Natural Gravels and Weathered Rocks for Use as Base Course Material (Graded Natural Gravel)

Test sieve (mm)	Percentage by mass of total aggregate passing test sieve	
	Nominal maximum particle size	
	37.5 mm	20 mm
50	100	-

37.5	80 – 100	100
20	60 – 80	80 – 100
10	45 – 65	55 – 80
5	30 – 50	40 – 60
2.36	20 – 40	30 – 50
0.425	10 – 25	12 – 27
0.075	5 – 15	5 – 15

b. Plasticity Index:
   1) The fine fraction of a Graded Crushed Stone material shall be non-plastic or shall have a maximum Plasticity Index of 6 when determined in accordance with AASHTO T-90.
   2) If the PI approaches the upper limit of 6, it is desirable that the fines content be restricted to the lower end of the range. To ensure this, a maximum PP of 60 is recommended or alternatively a maximum Plasticity Modulus (PM) of 90 where:
      a) PM = PI x (percentage passing the 0.425 mm sieve).

   3) If difficulties are encountered in meeting the plasticity criteria, consideration should be given to modifying the material by the addition of a low percentage of hydrated lime or cement.

c. Californian Bearing Ratio (CBR): When used as a base course, the material should be compacted to a density equal to or greater than 98 per cent of the maximum dry density achieved in the ASTM Test Method D 1557 (Heavy Compaction). When compacted to this density in the laboratory, the material should have a minimum CBR of 80% after four days immersion in water (ASTM D 1883).
d. Aggregate Crushing Value (ACV): Minimum soaked Ten percent Fines Value (TFV) Value (BS 812, Part 111) shall be 50 KN.
e. Abrasion: The Los Angeles Abrasion value, determined by testing in accordance with AASHTO T96 shall not exceed 45 at 500 revolutions unless otherwise specified in the Project Specifications.
f. Flakiness Index: The flakiness index shall not exceed 30% when determined in accordance with BS 812 Part 105-1990.
g. Crushed Ratio: The crushed ratio shall be a minimum of 60%.
h. Grading Modulus: The minimum Grading Modulus for material once placed and compacted on the road shall be:
   1) For natural material. . . . . 2.00.
   2) For material to be chemically stabilized . . . . . 1.75.

F. Suitable Material (Fill and Backfill for Landscaped Areas):
   1. Material consisting of mineral soil (inorganic), blasted or broken rock and similar materials of natural or man-made origin, including mixtures thereof. Maximum particle size will not exceed 2/3 of the specified layer thickness prior to compaction. NOTE: Material containing cinders, industrial waste, sludge, building rubble, land fill, muck, and peat will be considered unsuitable for fill and backfill, except topsoil and organic silt may be used as suitable material in landscaped areas provided it is placed in the top layer of the sub-grade surface.

G. Cushion material:

1. Will consist of clean, hard, durable, uncoated particles, free from lumps of clay and all deleterious substances.

H. Sand:
1. Crushed or natural stone and shall comply with the requirements of applicable Referenced Standards.

I. Coarse aggregate:
1. Crushed stone and shall comply with the requirements of applicable Referenced Standards.

J. Rip Rap:
1. Fine, light, medium or heavy stone filling that complies with the requirements of applicable Referenced Standards.

2.02 GEOTECHNICAL FABRICS

A. Filter Fabric (Geo-Textile): Comply with the requirements of the manufacturer's instructions.
1. Drainage and Erosion Control.
2. Separation for foundation drains, underdrains, undercuts.
3. Separation/Stabilization beneath pavements.

2.03 WASTE WATER MATERIAL

A. Crushed Stone, Crushed Gravel, or Screened Gravel:
1. Comply with the requirements of applicable Referenced Standards, except as indicated in the Contract Documents.

B. Sand Filter Material (Wastewater): Silica sand or other sound sand free from clay, loam, soft limestone or other impurities which may be disintegrated by sewage liquid. Comply with the requirements stated in the Contract Documents and applicable Referenced Standards. Comply also the following:
1. Organic Content: Less than 1 percent.
2. Uniformity Coefficient: 4.0 or less.
3. Calcium Carbonate Content: Less than 3 percent.
4. Shape: Rounded or oval. Do not use sharp sand, crushed flint or gravel.
5. Effective Size: As indicated.

2.04 SHEETING, SHORING, AND BRACING

A. Steel Sheet-piling: Continuous interlock type complete with all required accessories, complying with applicable Referenced Standards.
1. Furnish steel sheet-piling of design, configuration, and length to resist pressure of earth to be retained.

2.05 HARD CORE

A. Hardcore for floor and pavement sub-base:
1. Shall be approved stone meeting the requirements of stone masonry walls.
2. The maximum stone size shall be 20mm less than the finished hardcore thicknesses.

2.06 TERMITE PROTECTION MATERIAL

A. Termite protection material shall be as recommended by the manufacturer and subject to approval. The use of the trade name in the execution section of this specification is to establish the standard and not indicate any preference for the product.

PART 3 EXECUTION

3.01 EXAMINATION OF DRAWINGS

A. The contractor shall, before starting excavation, satisfy himself as to the accuracy of the levels shown on the Drawings or the directions given. Any discrepancies shall be reported to the Engineer's Representatives prior to proceeding with the works.

B. Comply with the requirements of ES 1648 and the following:
   1. Liaison: Liaise and cooperate with appropriate authorities, and with owners and occupiers of adjoining land or buildings likely to be affected by the Works.
      a. When it is necessary to make use of adjoining property, check that permission from the owners has been obtained.
      b. Clear away and make good any damage.
      c. Do not trespass on adjoining property.

   2. Existing drains and services: Locate the positions and levels of existing drains and services indicated on the Drawings before site work commences.
      a. Seek instructions on the method for dealing with those which are likely to be affected.

   3. Cable, pipes and services: Make the location of all underground cables and pipes with sign boards, indicating the type, for example, water, gas, electricity, telephone, cable TV, etc., and their depth. Where any overhead cables, etc., restrict headroom for site plant, install headroom indicators.

3.02 CLEARING AND GRUBBING

A. Clear and grub the Site trees, shrubs, brush, other prominent vegetation, debris, and obstructions to the required depth except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.
   1. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
   2. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching.

B. Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling, unless further excavation is indicated.

3.03 REMOVAL OF TOPSOIL

A. Remove existing topsoil from areas to the required depth where excavation or fill is required.

B. Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage.
   1. Topsoil will be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.

3.04 UNDERGROUND UTILITIES

A. Locate existing underground utilities prior to commencing excavation work. Determine exact utility locations by hand excavated test pits. Support and protect utilities to remain in place.

B. Unless specified otherwise do not interrupt existing utilities that are in service until temporary or new utilities are installed and operational.

C. Utilities to remain in service: Perform Works for utilities to be re-routed or others as shown on the Contract Drawings.

D. Utilities to be abandoned: Unless specified otherwise in the Contract Documents perform the followings;
   1. Utilities abandoned beneath and 1.5 m laterally beyond the structure's proposed footprint will be removed in their entirety. Excavations required for their removal will be backfilled and compacted as specified.
   2. Utilities extending outside the 1.5 m limit specified above may be abandoned in place provided their ends are adequately plugged as described below.
      a. Permanently close open ends of abandoned underground utilities exposed by excavations, which extend outside the limits of the area to be excavated.
      b. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs or other approved method for the type of material and size of pipe. Do not use wood plugs.
      c. Close open ends of concrete and masonry utilities with concrete or flow-able fill.

3.05 EXCAVATION

A. General: Except specified otherwise indicated in the Contract Documents, all excavation Works shall be performed in accordance with the requirements of ES 1648, BS 6031 and the following:

B. Excavate earth as required for the Work.

C. Install and maintain all erosion and sedimentation controls during all earthwork operations as specified on the Contract Drawings or as directed by local officials or/and Engineer's Representative. If the erosion and sedimentation controls specified by the local officials are more stringent than those specified on the Contract Drawings contact the Engineer's Representative.

D. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.
   1. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.

E. Stockpile excavated materials classified as suitable material where directed, until required for fill. Place, grade, and shape stockpiles for proper drainage as approved by the Engineer's Representative.

F. Excavation for Structures: Conform to elevations, lines, and limits indicated. Excavate to a vertical tolerance as required by the Contract Documents.

G. Footings and Foundations: The foundation bearing grade will be established just prior to constructing the concrete foundations when concrete is to bear on undisturbed soil.
   1. Stepping Footings: Cut sloping surfaces under footings, foundations, steps, and where required for other Work as indicated.
   2. Pile Foundations: Stop excavations as required by the Contract Documents or (usually 15 to 30 cm) above the bottom of pile cap elevation before the piles are placed. After pile installation, remove loose and displaced material and excavate to final grade, leaving a solid base to receive concrete pile caps.
   3. Where footings and other Work requiring similar soil support will rest entirely on rock, remove loose soil and loose rock and place concrete to the required elevations. Where footings and other Work requiring similar soil support will rest partially on rock and partially on soil, immediately notify the Engineer before any backfilling or concrete placement occurs; the Engineer will determine the correct foundation treatment for the Work.

H. Slabs and Floors: Excavate to the required depths as indicated in the Contract Drawings below bottom of concrete for addition of select granular material.

I. Pipe Trenches: Open only enough trench length to facilitate laying pipe sections. Excavate trenches to the required width as indicated on the Drawings, or complying with the referenced Standards. Cut trenches to cross section, elevation, profile, line, and grade indicated. Accurately grade and shape trench bottom for uniform bearing of pipe in undisturbed earth. Excavate at bell and coupling joints to allow ample room for proper pipe connections.

J. Open Ditches: Cut ditches to cross sections and grades indicated.

K. Pavement: Excavate to sub-grade surface elevation.

L. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the Engineer.
   1. Unauthorized excavations under structural Work such as footings, foundation bases, and retaining walls will be reported immediately to the Engineer before any concrete or backfilling Work commences.

M. Notify the Engineer's Representative upon completion of excavation operations. Do not proceed with the Work until the excavation is inspected and approved.

N. Removal of unsuitable material beneath structures and other improvements: Excavate encountered unsuitable materials, which extend below required elevations, to additional

depth as directed by the Engineer. Do not backfill this excavation prior to quantity measurement.

1. Such additional excavation and backfilling, not due to error, fault or neglect of the Contractor, will be paid for at the unit prices specified in the Contract Documents.

3.06 DEWATERING

A. Comply with the requirements of EBSC EN 1997:2015 [see section 5.4 of EBSC EN 1997-1:2015, DEWATERING] and the following:

B. Any scheme for removing water from the ground or for lowering the water pressure shall be based on the results of a geotechnical or hydro geological investigation.

C. Prior to the performance of any excavations provide dewatering methods such that the groundwater table is maintained at an elevation that is beneath the excavated depth.

D. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.

E. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of sub-grades and foundations. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.

F. Convey water removed from excavations, and rain water, to collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.

G. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

3.07 ANTI-TERMITE TREATMENT

B. Termite hills shall be removed and disposed to appropriate tip. The cavity formed by the removal of termite hills shall be treated with termite proof solution. Anti-termite treatment shall be applied over the whole area of the buildings and aprons. Follow manufacturer’s instruction for the application of anti-termite solution. Before treatment, the surface must be cleared of all rubbish and in particular scrap timber.

C. The treatment shall be on the ground after removal of top soil and/or soft layer and before making up levels.

3.08 SETTLEMENT DETECTION

A. Excavating beneath the bearing grades of an existing structure: Establish a settlement detection method approved by the Engineer’s Representative for structures subject to settlement from excavation, sheeting or sheet-piling operations. Maintain surveillance to detect any settlement.

B. Surcharging: Establish a settlement monitoring plan to accurately determine the settlements that have occurred and the rate that they occurred to adequately determine when settlement caused by surcharge is complete.

3.09 SHEETING, SHORING, AND BRACING

A. Temporary Sheeting: Install temporary sheeting or sheet-piling with shoring and bracing as required to create a safe working environment and prevent settlement or other damage to adjacent grounds and structures resulting from excavation operations. Shore and brace sheeting in a manner which will not interfere with progress of other Work or related contracts (if any) on this project. Check shoring and bracing for settlement, and adjust for settlement. Promptly remove temporary sheeting, shoring, and bracing when no longer required.

B. Permanent Sheeting: Install permanent steel sheet-piling where shown. Cut off top of permanent sheeting to the required depth below finish grade.

3.10 PLACING FILTER FABRIC

A. Place and overlap filter fabric in accordance with the manufacturer's installation instructions, unless otherwise shown.

B. Cover tears and other damaged areas with additional filter fabric layer extending 1 m beyond the damage.

C. Do not permit traffic or construction equipment directly on filter fabric.

D. Backfill over filter fabric within two weeks after placement. Backfill in accordance with the fabric manufacturer's instructions and in a manner to prevent damage to the fabric.

3.11 PLACING FILL AND BACKFILL

A. General: Except specified otherwise indicated in the Contract Documents, all fill Works shall be performed in accordance with the requirements of ES 1648, BS 6031 and the following:

B. Surface Preparation of Fill Areas: Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Remove all asphalt pavements in its entirety from areas requiring the placement of fill or break up old pavements to the required size as indicated. Prior to placement of fill, smooth out and compact areas where wheel rutting has occurred due to stripping or earthwork operations.

C. Excavations: Backfill as promptly as Work permits, but not until completion of the following:
   1. Acceptance by the Engineer's Representative of construction below finish grade including, where applicable, damp-proofing, waterproofing, perimeter insulation, and bearing capacity of supporting soil.
   2. Inspection, testing, approval, and recording locations of underground utilities.
   3. Removal of concrete formwork.
   4. Removal of temporary sheeting or sheet-piling and backfilling of voids caused by removals.
   5. Cutting off top of permanent sheeting or sheet-piling.

6. Removal of trash and debris.
7. Installation of permanent or temporary bracing on horizontally supported walls.

D. Place backfill and fill materials in layers not more than 20cm thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.
   1. Place fill and backfill against foundation walls and in confined areas such as trenches not easily accessible by larger compaction equipment, in maximum 15 cm thick loose depth layers.
   2. For large fill areas, the layer thickness may be modified by the Engineer's Representative, at the Contractor's written request, if in the Engineer's Representative's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request will include the type and specifications of compaction equipment intended for use.

E. Concrete walls: For the work of backfill against concrete wall indicated in the Contract Documents, perform the following:
   1. Do not place fill or backfill against concrete walls until the walls have attained 70 percent of their design strength. Place backfill against walls of structures containing basements or crawl spaces only after the first floor structural members are in place and any concrete components of the first floor structural system have attained 70 percent of their concrete design strength.
   2. Prevent wedging action of backfill against structures backfilled on both sides, by placing backfill uniformly around structure so that the elevation on each side never differs by more than 60 cm.

F. Foundation Drains: Unless other methods specified in the Contract Documents, perform the following for the required foundation drain works :
   1. Line pipe trench loosely with filter fabric. Lap successive sheets 45 cm.
   2. Place under-drain filter material a minimum of 10 cm deep under pipe and 15 cm on both sides and over top of drain pipe.
   3. Completely wrap under-drain filter material with filter fabric.
   4. Within two weeks complete balance of backfill with selected fill extending 60 cm out from foundation wall and up to 15 cm below finished grade.

G. Perimeter Insulation: Before the insulation is installed, place and tamp specified backfill to a smooth plane even with the required elevation of the lower surface of the insulation.

H. Under Exterior Concrete Slabs and Steps:
   1. Up to Sub-grade Surface Elevation: Place selected fill when fill or backfill is required.
   2. Sub-base Material: Place the required depth of select granular material over sub-grade surface.

I. Under Interior Concrete Slabs:
   1. Up to Sub-grade Surface Elevation: Place selected fill when fill or backfill is required.
   2. Sub-base material: Place the required depth of select granular material over sub-grade surface.

J. Under Pavements and Walks:

1. Up to sub-grade surface elevation: Place selected fill when fill or backfill is required.
2. Sub-base material: Place the required depth of select granular material over sub-grade surface as indicated.

K. Under asphalt concrete pavements:
1. Up to sub-grade surface elevation: Place selected fill when fill or backfill is required.
2. Sub-base material: Place the required depth of select granular material over sub-grade surface as indicated.
3. Base material: Place the required depth of select granular material over sub-base surface as indicated.

L. Landscaped Areas: Place suitable material when required to complete fill or backfill areas up to sub-grade surface elevation. Unless directed or indicated, do not use material containing rocks over 10 cm in diameter within the top 30 cm of suitable material.

M. Pipe Tunnels: Place selected fill to the required size on both sides and over top of tunnel.

N. Plastic Pipe in Trenches: Place cushion material to the required size under pipe, on both sides, and above top of pipe. Complete balance of backfill as specified.

O. Copper tubing and steel gas pipe in trenches: Place cushion material to the required size under pipe, on both sides, and above top of pipe. Complete balance of backfill as specified.

P. Backfilling excavation resulting from removal of unsuitable material beneath structures and other improvements: Backfill the excavation with compacted select granular material as indicated.

3.12 COMPACTION

A. General: Except specified otherwise indicated in the Contract Documents, all compaction Works shall be performed in accordance with the requirements of ES 1648, BS 6031 and the following:

B. Perform compaction as per the following requirements:
1. Compact each layer of fill and backfill for the following area classifications to the percentage of maximum density specified below and at a moisture content suitable to obtain the required densities, but at not less than three percent drier or more than two percent wetter than the optimum content.
   a. Structures (entire area within 3 m outside perimeter): 95 percent.
   b. Concrete Slabs and Steps: 95 percent.
   c. Landscaped Areas: 90 percent.
   d. Pavements and Walks: 95 percent.
   e. Pipes and Tunnels: 95 percent.
   f. Pipe Bedding: 95 percent.

2. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density.
3. Moisture Control:

a. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent pond or other free water on surface subsequent to, and during compaction operations.
b. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by appropriate methods until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.

4. If a compacted layer fails to meet the specified percentage of maximum density, the layer will be re-compacted and retested. If compaction cannot be achieved the material/layer will be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

C. Open graded Stone: Unless shown on Drawings, place material in maximum 30 cm lifts. Each lift shall be raked smooth and compacted through several passes of a walk behind vibratory roller.

3.13 ROUGH GRADING

A. Interior Grading: Trim unexcavated spaces within the building to levels indicated.
1. Sub-grade for interior slabs: Compact as specified to receive fill material. Finish sub-grade surface as indicated above or below level specified for fill required.

B. Exterior Grading: Trim and grade area within the required grading limit and excavations outside the grading limit to a level as required by this Contract, Provide smooth uniform transition to adjacent areas.
1. Slope cut and fills in transition areas, outside of the grading limit line, to meet corresponding levels of existing grades at a slope as indicated.
2. Landscaped Areas: Provide uniform sub-grade surface within a required level to receive topsoil thickness specified. Compact fill as specified. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil.

3.14 SUBGRADE SURFACE FOR WALKS AND PAVEMENT

A. Shape and grade sub-grade surface as follows:
1. Walks: Shape the surface of areas under walks to required line, grade and cross section, with the finish surface above or below the required sub-grade surface elevation as indicated.
2. Pavements: Shape the surface of areas under pavement to required line, grade and cross section, with the finish surface above or below the required sub-grade surface elevation as indicated.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of sub-base course.

C. Thoroughly compact sub-grade surface for walks and pavement by mechanical rolling, tamping, or with vibratory equipment as approved to the density specified.

D. Shoulders: Place shoulders along edges of filled sub-grades to prevent lateral movement. Construct shoulders of selected fill material, placed in such quantity to compact to thickness of each sub-grade course layer.

3.15 FINISH GRADING

A. Uniformly grade rough graded areas within grading limits to finish grade elevations indicated.

B. Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finish elevations are indicated or between such points and existing finished grade.

C. Grade areas, as required by the Contract Documents, adjacent to building lines so as to drain away from structures and to prevent ponding.

D. Finish surfaces free from irregular surface changes, and as follows:
   1. Grassed Areas: Finish areas to receive topsoil above or below the required sub-grade surface elevations indicated.
   2. Walks: Place and compact sub-base material as specified. Shape surface of areas under walks to required line, grade and cross section, with the finish surface above or below the required sub-base elevation indicated.
   3. Pavements: Place and compact sub-base material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface above or below the required sub-base elevation indicated.
   4. Building Slabs: Grade sub-base material smooth and even, free of voids, compacted as specified, and to required sub-base elevation. Finish final grades within a tolerance as indicated when tested with a ten foot straightedge.
   5. Surfaces to Receive Vapor Barrier: Provide smooth surfaces graded, tamped and/or rolled, entirely free of obstructions or protruding objects.

E. Spread topsoil directly upon prepared sub-grade surface to a required depth after natural settlement of the topsoil has occurred in areas to be seeded or to receive sod. Place to greater depth when necessary to adjust grades to required elevations.
   1. Approved existing topsoil within the Grading Limit Line may be used. Provide additional topsoil from outside sources as required.

F. Unless specified in the Contract Documents, finish topsoil surface free of depressions which will trap water, free of stones over 2.5 cm in any dimension, and free of debris.

3.16 MAINTENANCE AND RESTORATION

A. Restore grades to indicated levels where settlement or damage due to performance of the Work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.

B. Restore pavements, walks, curbs, lawns, and other exterior surfaces damaged during performance of the Work to match the appearance and performance of existing corresponding surfaces as closely as practicable.

C. Topsoil and seed or sod damaged lawn areas outside the grading limit and new lawn areas inside the grading limit. Water as required until physical completion of the Work.

3.17 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

A. Remove from the site and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.

B. Transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to appropriate area as indicated in the Contract Documents or/and designated by the Engineer's Representative, and dispose of such materials as directed.

C. Transport excess topsoil to appropriate area as indicated in the Contract Documents or/and designated by the Engineer's Representative. Smooth grade deposited topsoil as directed by the Engineer's Representative.

3.18 HARD CORE AND STONE FILLER

A. Hardcore shall be sound approved stone of specified finished thickness and placed as directed, and blinded with the required thickness of crushed aggregate.

3.19 FIELD QUALITY CONTROL

A. Compaction Testing: Notify the Engineer's Representative at least three working days in advance of all phases of filling and backfilling operations. Compaction testing will be performed on the representation of the Engineer's Representative to ascertain the compacted density of the fill and backfill materials. Compaction testing will be performed on certain layers of the fill and backfill as determined by the Engineer's Representative and/or indicated in the Contract Documents. If a compacted layer fails to meet the specified percentage of maximum density, the layer will be re-compacted and will be retested. No additional material may be placed over a compacted layer until the specified density is achieved.

3.20 PROTECTION

A. Protect graded areas from traffic and erosion, and keep them free of trash and debris.

END OF SECTION

SECTION 311000

SITE CLEARING

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Demolition: Section 024100.

B. Earthwork: Section 310000.

1.02 REFERENCES

Unless specified or indicated in the Contract Documents, the work of this Section shall comply with the requirements of the following Standards.

A. EBSC EN 1997:2015: Geotechnical Design.

B. ES 1648: Workmanship on Building Sites. Code of Practice for Excavation and Filling.

C. BS 6031: Code of Practices for Earthworks.

1.03 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog sheets, specifications, and application instructions for herbicides.

1.04 REGULATORY REQUIREMENTS

A. Open Fires:
   1. Comply with the Governmental rules and regulations for Environmental Conservation.

B. Herbicides:
   1. Comply with the Governmental rules and regulations for Environmental Conservation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Herbicides:
   1. A chemical or a combination of chemicals which, according to the manufacturer's label will kill stumps and roots.
      a. Deliver herbicides to the site in original manufacturer's containers indicating type & percentage of chemical, & application instructions.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection
   1. Prevent damage to buildings, pavement, pipes, conduits, poles and other structures above and below ground that are adjoining or included in the contract area. Repair damage resulting from the contractor's negligence.
   2. Protect existing trees and shrubs not to be removed. Cut back to point of branching all broken branches and skinned areas. Treat exposed wood with tree pruning compound.
   3. Store materials and equipment in cleared areas away from tree roots. Prevent employees and equipment from trampling over woodland, existing planting, and established lawns.

3.02 REMOVALS

A. Clear and grub the Site trees, shrubs, brush, other prominent vegetation, debris, and obstructions to the required depth except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.
   1. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
   2. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching.

B. Remove all living or dead tree and shrub growth where indicated or specified.

C. Top and limb all trees before felling, unless otherwise approved by the Engineer.

D. Cut all stumps 15 cm above ground or as required by the Contract Documents. Apply herbicide to the stumps and root area in accordance with the manufacturer's application instructions. Mix a red or yellow dye with the herbicide for identification purposes.

E. Chip out stumps to a depth of not less than 15 cm below finished grade or as required by the Contract Documents. Backfill stump holes with topsoil.

F. Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling of Earthwork Section 310000, unless further excavation is indicated.

3.03 PRUNING

A. Prune trees where indicated of undesirable wood with the resulting crown shaped to the natural habit of the tree. Remove all diseased and dead branches, and branches interfering with healthy growth. Scar trace bark wounds as directed. All cuts shall be cleanly made with sharp tools, flush with the parent trunk or limb.

3.04 CLEAN UP

A. Dispose of all diseased Elmwood within 4 days or as required by the Contract Documents after cutting by burning or by other methods approved by the concerned organization body of Environmental Conservation.

B. Remove and dispose of all logs, tree trimmings, and debris from site. Leave Work area in a neat uncluttered condition.

END OF SECTION

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DIVISION 32 – EXTERIOR IMPROVEMENTS

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SECTION 321000

BASES, BALLASTS AND PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section includes the construction of site works for concrete paving, stone paving, gravel surfacing, and concrete curbs.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Steel Concrete Reinforcement: Section 032100.

B. Cast-In-Place Concrete: Section 033000.

C. Earthwork: Section 310000.

1.03 REFERENCES

A. ES 3123: Pavements Constructed With Clay, Natural Stone Or Concrete Pavers Part 4. Code of Practice for the Construction of Pavements of Precast Concrete Flags or Natural Stone Slabs.

B. ES 3124: Pavements Constructed with Clay, Natural Stone, or Concrete Pavers - Part 7: Code of Practice for the Construction of Pavements of Natural Stone Setts and Cobbles.

C. ES 3291:2006: Kerbs of Natural Stone for External Paving - Requirements and Test Methods.

D. ES 2361: Precast Concrete Flags, Kerbs, Channels, Edgings and Quadrants - Part 3: Precast, Unreinforced Concrete Kerbs, Channels, Edgings and Quadrants - Requirements and Test Methods.

E. AASHTO M 213: Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

F. AASHTO T 27: Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.

G. AASHTO T 11: Standard Method of Test for Materials Finer Than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.

H. AASHTO T 96: Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

I. AASHTO T 180: Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

J. AASHTO T 190: Standard Method of Test for Resistance R-Value and Expansion

Pressure of Compacted Soils.

K. ASTM C 33: Standard Specification for Concrete Aggregates.

L. ASTM C 144: Standard Specification for Aggregate for Masonry Mortar.

1.04 SYSTEM DESCRIPTION

A. Site work concrete pavement, natural stone pavement, gravel surfacing, or curbs constructed upon the prepared subgrade and in conformance with the lines, grades, thickness, and cross sections shown.

1.05 SUBMITTALS

A. Product data:
   1. Mix Design:
      a. Submit proposed concrete design mix(es) at least 28 days prior to the start of concrete work.
      b. Include test results of proposed concrete proportions.

B. Sieve analyses for grading of bedding and joint sand.

C. Manufacturers' Certificates and Data certifying that the following materials conform to the requirements specified:
   1. Expansion joint filler.
   2. Reinforcement.

D. Data and Test Reports: Sub-base and gravel wearing course materials:
   1. Source, gradation, liquid limit, plasticity index, percentage of wear, and other tests as specified and in compliance with applicable Referenced Standards.

E. Samples:
   1. Bar Reinforcement: 3x1 meter minimum from each type.

1.06 QUALITY ASSURANCE

A. Comply with applicable requirements stated under Article 1.05 ‘QUALITY ASSURANCE’ of Section 033000, Cast-In-Place Concrete, for placing of concrete pavement.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Bedding and joint sand shall be covered with a secure waterproof covering to prevent exposure to rainfall or removal by wind.

B. Delivery and paving schedules shall be coordinated in order to minimize interference with normal use of buildings adjacent to paving.

C. Handle stone in a manner that will prevent chipping and other damage. Use suitable lifting devices.

1.08 ENVIRONMENTAL CONDITIONS

A. Sand shall not be installed during heavy rain or snowfall.

B. Frozen sand shall not be installed.

C. Placement of concrete shall be as specified under Article 3.03 'PLACING' of Section 033000, Cast-In-Place Concrete.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless indicated in the Contract Documents, comply with the material requirements specified hereunder in Part 2, for the execution Works in this Section of the Specifications.

2.02 CONCRETE

A. The production of concrete shall be in accordance with the requirements as specified in Section 033000, Cast-In-Place Concrete.
   1. Concrete type and grade: As indicated in the Contract Documents.

2.03 BAR REINFORCEMENT

A. Reinforcements shall conform to the requirements as specified in Section 032100, Steel Concrete Reinforcement.

B. The type, amount, and locations of steel reinforcement shall be as shown on the drawings and in the specifications.

2.04 KERBS

A. Comply with the requirements of ES 3291 for Kerbs produced from natural stone.

B. Comply with the requirements of ES 2361 for precast concrete Kerbs.

2.05 SUBBASE

A. Sub-base material shall consist of select granular material and shall conform to the requirements as specified in Section 310000, Earthwork.

2.06 GRAVEL WEARING COURSE

A. General:
   1. The material shall consist of hard durable angular particles produced by crushing rock, crushing gravel or from natural sources and shall be clean and free from organic matter, lumps of clay or other deleterious substances.
   2. The material shall be of such a nature that it can be readily laid and compacted without segregation.

3. They should have sufficient cohesion to prevent raveling and corrugating (especially in dry conditions).
4. The amount of fines (particularly plastic fines) should be limited to avoid a slippery surface under wet conditions.
5. Selected material shall consist of hard durable angular particles of fragments of stone or gravel. The material shall be free from vegetable matter and lumps or balls of clay.

B. Grading:
1. The grading of the gravel after placing and compaction shall be a smooth continuous curve within and approximately parallel to the envelopes or the grading limits shown in Table 1 when determined in accordance with the requirements of AASHTO T-27.
2. The mass of material passing the 0.075mm sieve shall be determined in accordance with the requirements of AASHTO T-11.

Table 1: Grading Requirements for Gravel Wearing Course and Gravel Shoulder

Test Sieve Size (mm)	Percent (%) by mass of total aggregate passing test sieve					
	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
50	-	-	-	100	-	-
37.5	100	-	100	80-100	-	-
28	-	100	95 - 100	-	-	-
20	80 - 100	95 - 100	85-100	60-80	100	-
14	-	80 - 100	65 - 100	-	-	-
10	55 - 100	65 - 100	55 - 100	45-65	80 - 100	100
5	40 - 60	45 - 85	35-90	30-50	60 -85	80-100
2.36	30 - 50	-	-	20-40	45-70	50-80
2	-	30 - 65	22-75	-	-	-
1	-	25-55	18-60	-	-	-
0.425	15 - 30	18 - 45	15-50	10-25	25-45	25-45
0.075	5 - 15	12-32	10-40	5-15	10-25	10-25

C. Unless and otherwise stated, comply the following:
1. Type 1 gravel wearing course shall be used for all roads which have Annual Average Daily Traffic design greater than 50.
2. Type 4 gravel wearing course shall be used in the new construction of roads having Annual Average Daily Traffic design less than 50.
3. The other Types of gravel wearing course materials shall be used as shown in the contract or as directed by the Engineer.
4. Type 1:
   a. The grading of this gravel after placing and compaction shall be a smooth curve within and approximately parallel to the envelopes detailed in Table 1.
   b. The material shall have a percentage of wear of not more than 50 at 500 revolutions, as determined by AASHTO T 96.
   c. The material shall be compacted to a minimum in-situ density of 95% of the maximum dry density determined in accordance with the requirements of AASHTO T 180.
   d. The plasticity index should be not greater than 15 and not less than 8 for wet climatic zones and should be not greater than 20 and not less than 10 for dry climatic zones.
   e. The linear Shrinkage should be in a range of 3-10%.

f. Note that the above gradation and plasticity requirements are only to be used with angular particles and that crushing and screening are likely to be required in many instances for this purpose. The crushed ratio shall be a minimum of 60%.

5. Type 2 & 3: These materials may be more rounded particles fulfilling the following:
   a. The Plasticity Index lies in a range of 5-12% in wet areas, and in any case less than 16% in other areas.
   b. The CBR should be in excess of 20% after 4 days of soaking at 95% of maximum dry density under Heavy Compaction. For very low traffic, the requirement may be relaxed to a CBR of 15.

6. Type 4:
   a. This material gradation allows for larger size material and corresponds to the gradation of a base course material. The use of this gradation of materials is subject to the local experience and shall be used with PIs in a range of 10-20.

7. Type 5 & 6:
   a. These materials gradations are recommended for smaller size particles. They may be used if sanctioned by experience with plasticity characteristics as for material Type 1.

2.07 NATURAL STONE SLABS

A. As indicated in the Contract Documents or comply with applicable Referenced Standards.

2.08 BEDDING AND JOINT SAND

A. Bedding and joint sand shall be clean, non-plastic, and free from deleterious or foreign matter. The sand shall be natural or manufactured from crushed rock. Limestone screenings or stone dusts that do not conform to the grading requirements in Table 3 shall not be used.

B. The bedding sand shall conform to the grading requirements of ASTM C 33 as shown in Table 2.

Table 2: Bedding Sand Grading Requirements

ASTM C 33	
Sieve Size	Percent Passing
No. 4	95 to 100
No. 8	85 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

C. The joint sand shall conform to the grading requirements of ASTM C 144 as shown in Table 3 below:

Table 3: Joint Sand Grading Requirements

ASTM C 144		
	Natural Sand	Manufactured Sand
Sieve Size	Percent Passing	Percent Passing
No. 4	100	100
No. 8	95 - 100	95 to 100
No. 16	70 - 100	70 to 100
No. 30	40 - 75	40 to 75
No. 50	10 - 35	20 to 40
No. 100	2 - 15	10 to 25
No. 200	0	0 to 10

2.09 FORMS

A. Use metal or wood forms that are straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating the concrete, for the work involved.

B. Wood forms shall be free from warp, twist, loose knots, splits, or other defects. Use approved flexible or curved forms for forming radii.

2.10 EXPANSION JOINT FILLERS

A. Material shall conform to AASHTO M 213.

PART 3 EXECUTION

3.01 SITE PREPARATION

A. Complete all underground utility work, curbing, trellis foundations, and wall construction prior to commencement of sub-base construction.

3.02 SUBGRADE PENETRATION

A. Prepare, construct, and finish the subgrade as specified in Section 310000, Earthwork.

B. Maintain the subgrade in a smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

C. Under no circumstances shall further pavement construction proceed until the subgrade has been inspected and approved by the Engineer’s Representative.

3.03 SUBBASE (WHERE REQUIRED)

A. Place and compact sub-base materials in uniform lifts as specified in Section 310000, Earthwork.

B. Protection:
   1. Placing of concrete over sub-base: Maintain the finished sub-base in a smooth and compacted condition until the concrete has been placed.

C. Placing of sand over sub-base: The upper surface of the sub-base shall be sufficiently well graded and compacted to prevent infiltration of the bedding sand into the base both during construction and throughout its service life. Segregated areas of the granular base shall be blended by the application of crushed fines that have been watered and compacted into the surface.

3.04 GRAVEL SURFACING

A. Equipment:
   1. Gravel wearing course and gravel shoulder material shall be spread by means of graders or other equipment approved by the Engineer.
   2. Gravel wearing course and gravel shoulder material shall be compacted by means of self-propelled or towed steel wheeled rollers which are capable of achieving the density requirements stipulated in this Section.
   3. Water shall be applied by means of equipment, which is capable of distributing the applied water uniformly over the surface of the layer.

B. Placing and Spreading:
   1. The material shall be placed, spread, broken down, watered if necessary and mixed in layers not exceeding 200mm and not less than 100mm compacted thickness for Type 1, Type 2, Type 3, Type 5, Type 6 and 150mm compacted thickness for Type 4.

C. Compaction:
   1. Prior to compaction, the moisture content of the spread material shall be adjusted as necessary either by the uniform application of water or drying out, to achieve within -1% to +2% of the optimum moisture content when determined in accordance with AASHTO T-180.
   2. The material shall be compacted by the use of approved rollers progressing gradually from the outside towards the center of the layer, except on super-elevated curves, where the rolling shall begin at the low side and progress to the high side. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. Rolling shall continue until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density.
   3. Any area, which is inaccessible to rolling equipment, shall be compacted by means of mechanical tampers or other equipment approved by the Engineer.
   4. Upon completion of compaction, the surface of the completed layer shall be tightly bound, free from movement under the compaction plant, and free from laminations, ridges, cracks or loose or segregated material.
   5. The in-situ density of the completed layer shall be 95% of the maximum dry density when determined in accordance with the requirements of AASHTO T-180 method D. The dry density shall be determined in accordance with the requirements of AASHTO T-190.

D. Tolerances:
   1. Level: The level tolerance shall be + 25 mm.
   2. Thickness: The thickness tolerance shall be + 30 mm.

3.05 SAND BEDDING (WHERE REQUIRED)

A. Before commencing the placing of the sand bedding course and the placement of the interlocking concrete pavers, the base shall be inspected by the Engineer's Representative.

B. The sand shall be spread evenly over the base course and screeded to the required nominal thickness. The screeded sand should not be disturbed.

C. Excess joint sand shall be swept off when the job is complete.

3.06 SETTING FORMS

A. Base Support:
   1. Compact the base material under the forms true to grade so that, when set, they will be uniformly supported for their entire length at the grade as shown.
   2. Correct imperfections or variations in the base material grade by cutting or filling and compacting.

B. Form Setting:
   1. Set forms sufficiently in advance of the placing of the concrete to permit the performance and approval of all operations required with and adjacent to the form lines.
   2. Set forms to true line and grade and use stakes, clamps, spreaders, and braces to hold them rigidly in place so that the forms and joints are free from play or movement in any direction.
   3. Forms shall conform to line and grade with the required allowable tolerance as specified or complying to applicable Referenced Standards.
   4. Do not remove forms until removal will not result in damaged concrete or at such time to facilitate finishing.
   5. Clean and oil forms each time they are used.
   6. Make necessary corrections to forms immediately before placing concrete.
   7. When any form has been disturbed or any subgrade or sub-base has become unstable, reset and recheck the form before placing concrete.

3.07 PLACING REINFORCEMENT

A. Reinforcement shall be free from dirt, oil, rust, scale or other substances that prevent the bonding of the concrete to the reinforcement.

B. Before the concrete is placed, the Engineer's Representative shall approve the reinforcement, which shall be accurately and securely fastened in place with suitable supports and ties. The type, amount, and position of the reinforcement shall be as shown.

3.08 PLACING CONCRETE - GENERAL

A. Obtain approval of the Engineer's Representative before placing concrete.

B. Remove debris and other foreign material from between the forms before placing concrete. Obtain approval of the Engineer's Representative before placing concrete.

C. Before the concrete is placed, uniformly moisten the subgrade, base, or sub-base appropriately, avoiding puddles of water.

D. Convey concrete from mixer to final place of deposit by a method which will prevent segregation or loss of ingredients. Deposit concrete so that it requires as little handling as possible.

E. While being placed, spade or vibrate and compact the concrete with suitable tools to prevent the formation of voids or honeycomb pockets. Vibrate concrete well against forms and along joints. Over-vibration or manipulation causing segregation will not be permitted. Place concrete continuously between joints without bulkheads.

F. Install a construction joint whenever the placing of concrete is suspended for more than 30 minutes and at the end of each day's work.

G. Workmen or construction equipment coated with foreign material shall not be permitted to walk or operate in the concrete during placement and finishing operations.

3.09 PLACING CONCRETE FOR KERB AND PAVEMENT

A. Place concrete in the forms in one layer of such thickness that, when compacted and finished, it will conform to the cross section as shown.

B. Deposit concrete as near to joints as possible without disturbing them but do not dump onto a joint assembly.

C. After the concrete has been placed in the forms, use a strike-off guided by the side forms to bring the surface to the proper section to be compacted.

D. Consolidate the concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.

E. Finish the surface to grade with a wood or metal float.

F. All Concrete pavements shall be constructed with sufficient slope to drain properly.

3.10 CONCRETE FINISHING CURB AND PAVEMENT

A. Kerb:
   1. Float the surfaces and finish with a smooth wood or metal float until true to grade and section and uniform in textures.
   2. Finish the surface, while still wet, with a bristle type brush with longitudinal strokes.
   3. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the surface, while still wet, in the same manner as the gutter and curb top.
   4. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.
   5. Correct any depressions which will not drain.
   6. Visible surfaces and edges of finished curb shall be free of blemishes, form marks, and tool marks, and shall be uniform in color, shape, and appearance.

B. Pavement:
   1. Finish the surfaces to grade and cross section with a metal float, troweled smooth

and finished with a broom moistened with clear water.

2. Brooming shall be transverse to the line of traffic.
3. Finish all slab edges, including those at formed joints, carefully with an edger having a radius as shown on the Drawings.
4. Unless otherwise indicated, edge the transverse joints before brooming. The brooming shall eliminate the flat surface left by the surface face of the edger. Execute the brooming so that the corrugation, thus produced, will be uniform in appearance and not more than 2 mm (1/16 inch) in depth.
5. The completed surface shall be uniform in color and free of surface blemishes, form marks, and tool marks.

3.11 PAVING NATURAL STONE

A. Comply with the requirements of ES 3123 for the construction of pavements of natural stone slabs.

B. Comply with the requirements of ES 3124 for the construction of pavements of natural stone setts and cobbles.

C. Size: As indicated.

D. Colour: As indicated or approved by the Engineer.

3.12 JOINTS

A. General:
   1. Place joints, where shown, conforming to the details as shown, and perpendicular to the finished grade of the concrete surface.
   2. Joints shall be straight and continuous from edge to edge of the pavement.

B. Expansion joints:
   1. Use a preformed expansion joint filler material of the thickness as shown to form expansion joints.
   2. Material shall extend the full depth of concrete, cut and shaped to the cross section as shown, except that top edges of joint filler shall be below the finished concrete surface where shown to allow for sealing.
   3. Anchor with approved devices to prevent displacing during placing and finishing operations.
   4. Round the edges of joints with an edging tool.
   5. Form expansion joints as required.

3.13 FIELD QUALITY CONTROL

A. Final elevations shall be checked for conformance to the drawings after removal of excess joint sand.

3.14 REPAIRS AND PROTECTIONS

A. The contractor shall protect the concrete against all damage prior to final acceptance by the Procuring Entity.

B. Repair or replace broken or defective concrete, as directed by the Engineer's

Representative.

C. Exclude traffic from vehicular pavement until the concrete is at least seven days old, or for a longer period of time if so directed by the Engineer's Representative.

END OF SECTION

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SECTION 321216

ASPHALT CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section includes the construction of site works for asphalt concrete road, parking, and walks.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: Section 310000.

1.03 REFERENCES

A. ES ISO 1419: Bitumens for Building and Civil Engineering — Part 1: Specification for bitumens for Roads and other Paved Areas.

B. ES 2287: Aggregates for Unbound and Hydraulically Bound Materials for Use in Civil Engineering Work and Road Construction.

C. BS 594987: Asphalts for Road and Other Paved Areas – Specification for Transport, Laying and Compaction and Type Testing Protocols.

D. AASHTO M 81: Standard Specification for Cutback Asphalt (Rapid-Curing Type).

E. AASHTO M 82: Standard Specification for Cutback Asphalt (Medium-Curing Type).

F. AASHTO M-140: Standard Specification for Emulsified Asphalt.

G. AASHTO M-208: Standard Specification for Cationic Emulsified Asphalt.

1.04 SYSTEM DESCRIPTION

A. The composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.05 SUBMITTALS

A. Product Data: Manufacturer’s name, specifications, and installation instructions, for each item specified.

B. Data and Test Reports:
   1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other required tests.

2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other required tests.

C. Quality Control Submittals:
   1. Plant name and location of asphalt concrete supplier(s).
   2. The Contractor shall provide to the Engineer certificates issued by all suppliers of bituminous binders to the effect that the binders delivered to the Site comply with the test requirements of applicable Standards.

1.06 QUALITY ASSURANCE

A. The laying operation shall be controlled and carried out by trained and experienced personnel.

B. Rollers and other compaction equipment shall be operated by skilled, experienced personnel.

C. Quality control: The Engineer shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

D. The Engineer shall have the authority to order the Contractor to have the bituminous binders tested by an approved laboratory for compliance with all or any of the requirements specified and the results of such tests shall be submitted directly by the testing laboratory to the Engineer with copies if requested to the Contractor.

1.07 PROJECT CONDITIONS

A. General: Comply with BS 594987 and the following for weather and other limitations for the construction of asphalt concrete paving.

B. Environmental Requirements:
   1. No prime or tack coat shall be applied under the following adverse conditions:
      a. During foggy or wet conditions.
      b. When rain is imminent.
      c. When wind is sufficiently strong to cause uneven spraying.
      d. When the surface of the layer is wet, i.e. more than damp.
      e. When at any position the moisture content of the top 25 mm of the layer to be primed is greater than 50% of the optimum moisture content of the material in the layer.
      f. When the temperature of the surface of the layer immediately prior to commencing the application of the tack coat is below 20^0 C.
      g. When the temperature of the surface immediately prior to commencing the application of the prime is below or, in the opinion of the Engineer, likely to fall below 10^0 C.
      h. After sunset.

   2. Discontinue paving when surface temperatures fall below requirements.
   3. Do not place asphalt concrete on wet surfaces, or when weather conditions otherwise prevent the proper handling or finishing of bituminous mixtures as determined by the Engineer’s Representative.

1.08 DELIVERY, STORAGE, AND HANDLING

A. General: In addition to the requirements of the Contract Documents, comply with BS 594987 and the following and also the requirements of other applicable Standards and Technical Specifications as agreed by the Engineer for delivery, storage and handling of materials and components used for the construction of asphalt concrete paving.

B. Loading of asphalt shall be carried out such that segregation is minimized.

C. Asphalt shall be transported to the laying site in insulated and sheeted vehicles to prevent an excessive drop in temperature and to ensure its protection against adverse weather conditions.

D. Deliveries of asphalt to the laying site shall be co-ordinated with the rate of laying to avoid interruption to the laying process.

E. Storage of prime coat and tack coat materials:
   1. All prime and tack coat materials stored in a heated condition shall be stored in a container with a properly functioning circulation system and a securely fitting lid. Unless the prime and tack coat material is intended for immediate use, no heat shall be applied to material delivered above storage temperature until the temperature is below those specified in table 1 and table 2 respectively. To prevent undue evaporation of volatiles, which will result in hardening of the material, prime and tack coat shall not be heated to a temperature greater than 10^{o} C above the range specified. When prime has to be heated from the cold state, it shall be heated slowly to avoid overheating that part of the prime and tack coat that is close to the source of heat. Heated storage tanks shall be fitted with suitable dial-type calibrated temperature indicators to show both the temperature in the tank close to the source of heat and, as accurately as possible, the maximum temperature of the binder in the tank.

F. Bituminous binders:
   1. Binders stored in a heated condition shall be kept in a container having a properly functioning circulatory system and a securely fitting lid. The container shall have a properly functioning built-in thermometer.
   2. Binders that have been heated above the maximum temperatures indicated in Table 3 shall not be used and shall be removed from Site.

Table 1 – Recommended storage and application temperatures

Type of prime	* Maximum storage temperature ^{o} C		* Spraying Temperature range ^{o} C
	Up to 24 hrs	More than 24 hrs	
Cut-back bitumen			
MC-30	50	30	45 - 60
MC-70	70	50	60 - 80
MC-250	90	70	75 - 90
Invert bitumen emulsion	60	Air	50 - 70

* Temperatures may be above the flash point of some materials. Care must be taken to prevent fire and explosion.

Table 2 – Recommended storage and application temperatures

Type of tack coat	* Maximum storage temperature ^{o}C		* Spraying Temperature ^{o}C	
	Up to 24 hrs	More than 24 hrs	Range	Recommended
RC 70 Cutback Bitumen	70	50	27 - 65	60
Bitumen emulsion	60	Ambient	50 - 70	60

* Temperatures may be above the flash point of some materials. Care must be taken to prevent fire and explosion.

Table 3 – Storage and spraying temperature for bituminous binders

Materials	* Maximum storage temperature ^{o}C		* Heating and Spraying Temperature ^{o}C		
	< 24 hours	> 24 hours	Minimum	Maximum	Recommended
Penetration-grade bitumens					
60/70	175	125	170	190	180
80/100	175	125	165	190	175
150/200	165	115	150	175	165
Cut-back bitumens					
RC-250	90	60	90	115	100
MC-800	125	75	110	135	125
MC-3000	155	100	135	155	145
Bitumen emulsions					
60 %	60	Ambient	Ambient	60	60
65 %	60	Ambient	50	60	60
70 %	60	Ambient	55	65	65

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless specified or indicated in the Contract Documents, aggregate base, Asphaltic base and asphalt concrete materials shall conform to the requirements of the following and other applicable Standards and Technical Specifications.

B. Bituminous prime coat:
   1. Priming material: The priming material shall be one of the following as specified or as directed by the Engineer:
      a. MC-30, MC-70, or MC-250 cutback bitumen complying with AASHTO M 81 or M 82, as applicable.
         1) Invert bitumen emulsion complying with SABS 1260.

2. Mineral Aggregate for Blinding: The aggregate used for blinding the primed surface shall consist of crushed rock or river sand, with 100% passing the 6.7 mm sieve and not more than 10% passing the 2.36 mm sieve. The aggregate shall be clean, hard and free from excessive dust. It shall contain no clay, loam, or other deleterious matter.

C. Tack Coat: The material used for tack coats shall be one of the following as specified or as directed by the Engineer:
   1. RC-70 cutback bitumen complying with AASHTO M 81 or M 82, as applicable.
   2. Bitumen emulsion complying with AASHTO M-140 or M-208.

D. Bituminous binders in general: Bituminous binders shall comply with the following:
   1. Penetration-grade bitumens - AASHTO M 20.
   2. Cutback bitumens - AASHTO M 82.
   3. Anionic bitumen emulsions (emulsified asphalts) - AASHTO M 140.
   4. Cationic bitumen emulsions (emulsified asphalts) - AASHTO M 208.
   5. Comply also with ES ISO 1419 as an alternative as appropriate.

E. Aggregates:
   1. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.
   2. Sub-base aggregate (where required): As specified in Section 310000, Earthwork.
   3. Base aggregate: As specified in Section 310000, Earthwork.
   4. Aggregates for asphaltic concrete paving: Provide a mixture of sand, mineral aggregate, and liquid asphalt mixed in such proportions that the percentage by weight will be within the requirements.
   5. Aggregates for Unbound and Hydraulically Bound Materials: Comply also with ES 2287 as an alternative as appropriate.

PART 3 EXECUTION

3.01 GENERAL

A. Unless specified or indicated in the Contract Documents, the Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, field quality control and protection shall conform to BS 594987 as appropriate and the following for the type of material specified.

3.02 PREPARATION

A. The areas to be surfaced or sealed shall be cleaned of all dust, dirt, dung, oil, or any other foreign materials that may be deleterious to the surface treatment.

B. Preparation of the layer to be primed:
   1. Before any prime material is sprayed, the layer to be primed shall be checked for compliance with the surface and other requirements specified. All superficial laitance of fine material and animal droppings shall be removed and may require the use of water, brooms and spades.

2. Not more than 24 hours before spraying, the layer to be primed shall be broomed and cleaned of all loose or deleterious material by means of a rotary broom and hand brooms. Surfaces that are open textured may require the use compressed air. Brooming and cleaning shall be done carefully so as to avoid any damage to the layer.
3. A light spray of water, sufficient to dampen the surface, shall be applied uniformly to the layer immediately before the application of the prime. If excess water is over applied, the layer shall be allowed to dry until a uniform damp surface is obtained.
4. If dust has been deposited, for whatever reason, on the surface to be primed between the time it has been broomed and the time considered for application, it shall be broomed and cleaned again to the satisfaction of the Engineer.

C. Preparation of the surface to be treated:
1. Prior to the application of the tack coat, the surface to be treated shall be checked for compliance with the surface and other requirements specified. Not more than four (4) hours before application of the tack coat, the surface shall be cleaned of loose material, dust, animal droppings and other deleterious materials, which may require the use of water, approved mechanical brooms or blowers, hand brooms and spades.
2. Surfaces that are open textured may require the use compressed air. Brooming and cleaning shall be done carefully so as to avoid any damage to the layer.
3. If dust has been deposited, for whatever reason, on the surface to be treated between the time it has been broomed and the time considered for application, it shall be broomed and cleaned again to the satisfaction of the Engineer.

3.03 SUBGRADE

A. Prepare, construct, and finish the subgrade as specified in Section 310000, Earthwork.
1. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.
2. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.

3.04 SUB-BASE AND BASE COURSES

A. Place and compact sub-base and base materials in uniform lifts as specified in Section 310000, Earthwork.
1. Spread and compact to the thickness shown on the drawings.

3.05 ASPHALT CONCRETE PAVING

A. Unless specified or indicated in the Contract Documents, asphalt shall be machine laid by a self-propelled paver except when hand laying is necessary complying with the requirements of BS 594987.
1. The paver used shall be capable of laying the asphalt continuously so as to produce an even and compact surface to the required widths, thicknesses, profiles, cambers and cross falls without causing segregation, dragging, burning, surface defects or irregularities. It shall also be capable of operating at such a speed as to permit continuous laying as far as supply and site conditions allow.
2. Hand laying shall be used only when site conditions make machine aying impractical or when small quantities of asphalt are being laid.

B. Remove all loose materials from the compacted base.

C. Prime coat and tack coat: The rate of application shall be as indicated in the Contract Documents. In the case where no data is indicated in the Contract Documents, comply the following under the direction of the Engineer.
   1. In general, the rate of application of prime shall be in the range of 0.6 – 1.0 liter/m^2 residual bitumen.
   2. In general, the rate of application of tack coat shall be in the range of 0.1 to 0.2 kg/m^2 of residual bitumen.
   3. Recommended spraying temperatures for prime coat and tack coat are given in Table 1 and Table 2 respectively.
   4. Tolerances:
      a. The actual spray rates shall not deviate from the required spray rate as specified or ordered by the Engineer by more than 0.05 liter/m^2.

D. Bituminous binders:
   1. The quantity of bitumen sprayed in any single spray operation shall be governed by the quantity of chippings and the number of available trucks, which shall be sufficient to ensure the continuous application of stone behind the distributor.

E. Asphalt concrete material: Do not accept material unless it is covered with appropriate material until unloaded, and unless the material has a temperature of not less than the required temperature.

F. Spreading: Spread material in a manner that requires the least handling.

G. All binders, chippings and other aggregates and slurry used in the various types of bituminous surface treatment shall be applied at the rates of application as approved by the Engineer after tests on the materials proposed for use, within a tolerance specified.

H. Rolling: After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown own the drawings.
   1. Rolling shall be undertaken in such a way as to achieve the correct surface profile and finish and the required degree of compaction.
   2. Laying of asphalt shall not commence until the rollers and their operators are at the place of laying and ready to commence compaction. The asphalt shall be compacted as soon as rolling can be undertaken without causing undue displacement or surface cracking of the asphalt.
   3. Compaction shall be such that there are no distinct roller marks left on the surface. Rollers shall not be allowed to stand on compacted asphalt that is still warm enough to result in indentation.

I. Surface regularity, contour and falls: The new asphalt surface, on completion of rolling, shall conform to the required levels and contour within the tolerances as indicated, if not comply with applicable Referenced Standards.

3.06 PROTECTION

A. Care shall be taken to protect any kerbing, guardrails, channeling, and gutters from the prime by covering with a suitable protective material when spraying. The contractor

shall, at his own cost, replace all soiled items that cannot be properly cleaned. Painting the soiled surfaces will not be accepted as a suitable remedial measure.

B. After the prime has penetrated sufficiently, surplus prime shall be covered with damp crusher sand, which shall be worked into it by means of hand brooms in order to absorb the surplus prime. As soon as it is saturated with prime, the crusher sand shall be swept off the primed surface. The process shall be repeated until no surplus prime remains on the primed surface.

C. Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

END OF SECTION

Ministry of Construction

SECTION 323100

FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

A. ES 2885: Steel Wire and Wire Products for Fences – Part 7: Steel Wire Welded Panels for Fencing.

B. ES 3050: Fences – Part 2: Specification for Strained Wire and Wire Mesh Netting Fences.

C. ES 3051: Fences – Part 10: Specification for Anti-Intruder Fences in Chain Link and Welded Mesh.

D. ES 3052: Fences – Part 11: Specification for Prefabricated Wood Panel Fences.

E. ES 3053: Fences – Part 12: Specification for Steel Palisade Fences.

F. ES 2342: Precast Concrete Products – Elements for Fences.

G. ES 3058: Domestic Front Entrance Gates Part 1. Specification for Metal Gates.

H. BS 1722-(all parts):1999: Fences.

I. BS 6100-1-3-0: Glossary of Building and Civil Engineering – Terms Part 1. General and Miscellaneous – Section 1.3: Parts of Construction Works – Subsections 1.3.0: External Works.

1.02 DEFINITIONS

A. Unless specified otherwise, the terms in this section shall conform to the terms and definition stated in BS 6100-1-3-0 and the following:
   1. Fence: Non-loadbearing vertical construction, other than a wall, that bounds or subdivides an external area.
   2. Fencing: Components used to form a fence.
   3. Gate: Construction in a fence, hedge or boundary wall that can be opened to allow access.
   4. Palisade fence: Fence that consists of closely spaced vertical members fixed to rails and supported by posts.
   5. Post and rail fence: Fence that consists of rails supported by posts with or without intermediate vertical members.
   6. Strained wire fence: Fence that consists of a set of parallel strainer wires set between and supported by posts and strained wire.
   7. Mesh fence: Fence that consists of wire mesh fixed to and supported by posts.
   8. Continuous bar fence: Fence that consists of horizontal steel bars supported by posts with or without intermediate vertical members.
   9. Concrete panel fence: Fence that consists of horizontal slabs of concrete located in grooves in supporting posts.

10. Post and chain fence: Fence that consists of a series of chains hanging between posts.

1.03 SUBMITTALS

A. Shop Drawings: Complete detailed drawings for each height and style of fence and gate required. Include separate schedule for each listing all materials required and technical data such as size, weight, and finish, to ensure conformance to specifications.

B. Product Data: Manufacturer's catalog cuts, specifications, and installation instructions for each item specified.

C. Samples: Samples for all fencing materials shall get approval by the Engineer before delivering to the site.
   1. Chain link mesh and others, wood panels, etc.: Minimum one square meter.
   2. Wires (barbed wire, linear wire, tying wire, etc.): Minimum one meter of three pieces for each type.
   3. Fence and Gate Posts: Two each, one meter long, if requested.

D. Quality Control Submittals:
   1. Test Reports: Security coils test procedure report.
   2. Certificates: Affidavit required under Quality Assurance Article.

1.04 QUALITY ASSURANCE

A. Unless specified otherwise provide steel fence and related gates as a complete compatible system including necessary erection accessories, fittings, and fastenings.

B. Posts and rails shall be continuous without splices.

C. Security coils certification: Affidavit by the supplier/contractor, certifying that the installation of the security coils meets the Contract requirements.

D. Statement of conformity: The manufacturer of steel palisade fence and/or gates shall provide with a certificate conforming that the fence and/or gates are manufactured and tested in accordance with the requirements stated in ES 3053.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless specified in the Contract Documents, the material for fencing and gates shall comply with the requirements of applicable Referenced Standards.
   1. Steel wire welded panels for fencing shall comply with ES 2885.
   2. Elements of precast concrete products used for fences shall comply with the requirements of ES 2342.

2.02 CHAIN LINK FENCES

A. Unless specified in the Contract Documents, wires and chain link mesh shall conform to the requirements of BS 1722-1:

1. Chain link mesh shall be zinc or zinc alloy or plastic coated wire conforming to the requirements stated in BS 1722-1.
2. The nominal diameter of stirrup wire shall be 2.5 mm.
3. Organic coated stirrup wire shall be of nominal core diameter 2.0 mm and nominal outside diameter 3.5 mm.
4. Zinc or zinc alloy coated tying wire shall be of low carbon (mild) steel, of nominal diameter 2 mm.
5. Organic coated tying wire shall be of nominal core diameter 1.4 mm and nominal outside diameter 2 mm.

B. Concrete posts and struts:
1. Unless specified in the Contract Documents concrete posts and struts shall be of steel reinforced concrete with recommended size and quality conforming to the requirements stated in BS 1722-1.

C. Dimensions:
1. Unless specified in Drawings, the overall dimensions of chain link fence types shall conform to the requirements stated in BS 1722-1.

2.03 STEEL PALISADE FENCES

A. General: Unless specified in the Contract Documents, fencing materials shall conform to ES 3053.

B. Steel:
1. Pales can be angle or corrugated type and shall be formed from a minimum steel grade conforming to the requirements and be suitable for galvanizing.
2. Posts shall be hot rolled to a minimum sections shown in ES 3053.

C. Bolts, nuts and washers:
1. Panel fixing bolts fixing bolts shall be cup square headed.
2. Bolts for pales shall have special formed heads to suit pale profiles and shall be tamper resistant, i.e. not easily removed using simple tools.
3. Bolts, nuts and washers shall have a surface protection of electrolytic zinc conforming to the requirements.

D. Cold swaged pin and collar fixings:
1. Cold swaged collar grooved or grooved fasteners shall be formed from carbon boron steel conforming to the requirements.
2. Cold swaged pin and collar fixings shall have a surface protection of electrolytic zinc conforming to the requirements.

E. Dimension:
1. Unless specified in the Contract Documents, comply with the requirements of ES 3053 for the minimum dimensions of components for the following:
   a. Basic dimensions for general purpose fences with posts at 2.75 m centers.
   b. Basic dimensions for security purpose fences with posts at 2.75 m centers.
   c. Frame sizes for individual gate leaf widths.
   d. Size of steel posts for individual gate leaf widths.
   e. Typical profile and nominal thickness of pales.

2. The maximum spacing of pales center to center and the minimum face to view width shall be kept as per the specified requirements.

2.04 STRAINED WIRE FENCES

A. Unless specified in the Contract Documents, wires shall conform to the requirements of BS 1722-3:
   1. Line wire: Shall be one of the following:
      a. Zinc coated low carbon (mild) steel with a nominal diameter of 4.0 mm, 4.5 mm or 5.0 mm; or
      b. Zinc coated high tensile wire with a nominal diameter of 3.15 mm; or
      c. Plastic coated high tensile wire having a tensile strength of 1050 N/mm^2 with zinc coated core of 3.15 mm nominal core diameter and 4.0 mm overall diameter.

   2. Stirrup wire: Shall be zinc or plastics (grade A) coated low carbon (mild) steel and shall have a nominal wire core diameter of 2.5 mm.
   3. Barbed wire: Shall be zinc coated and shall be made from either low carbon (mild) steel wire or high tensile steel wire.

B. Concrete posts and struts:
   1. Unless specified in the Contract Documents concrete posts and struts shall be of steel reinforced concrete with recommended size and quality conforming to the requirements stated in BS 1722-3.

C. Steel posts and struts:
   1. Unless specified in the Contract Documents steel posts and struts shall be of recommended size and quality as stated in BS 1722-3 and shall be free from sharp edges and burrs.
   2. The top of all hollow steel posts shall be capped.

D. Timber posts and struts:
   1. Unless specified in the Contract Documents timber posts and struts shall be of square sawn, round or cleft of recommended size and quality as stated in BS 1722-3 and shall have the same cross-section throughout.

E. Fittings: Unless specified in the Contract Documents, the size and quality of fittings shall comply with the requirements of BS 1722-3.
   1. Eye bolt strainers shall be hot dip galvanized that consists of bolts 250 mm overall length and not less than 9.5 mm diameter with a welded eye at one end.
   2. Winding brackets shall be manufactured from mild steel flat of appropriate size.
   3. Bolts, nuts, washers and nails shall comply with the requirements.

F. Dimensions:
   1. Unless specified in Drawings, the overall dimensions of strained wire fence (height of top wire, number of horizontal wires, and spacing between horizontal wires) shall conform to the requirements stated in BS 1722-3.

2.05 WOOD PANEL FENCES

A. Prefabricated wood panel fences: Comply with ES 3052.

2.06 STEEL BAR FENCES

A. Mild steel (low carbon steel) continuous bar fences and hurdles: Comply with BS 1722-8.
   1. Unless specified in the Contract Documents, comply with the requirements for types, categories and dimensions of continuous bars and welded hurdles used for fencings.
   2. Horizontal bars shall be spaced in accordance with the requirements as given in BS 1722-8.

2.07 GATES

A. General: Unless specified in the Contract Documents, the materials and components of gates shall comply with applicable Referenced Standards.
   1. Comply with ES 3058 for domestic front entrance metal gates.

2.08 SOURCE QUALITY CONTROL

A. Security Coils: The Company producing the security coils conform that the security coils required for the construction meets the requirements of applicable Referenced Standards. Test certificate that conforms to the requirements shall be submitted to the Engineer for approval or as per the interest of the Engineer, the following procedures shall be performed:
   1. Sampling before delivery to job site: Samples for quality conformance shall be selected in accordance with the requirements.
   2. Tests for the selected sample shall be conducted by the recognized testing organization in the representative of the Engineers Representative.
   3. After the satisfaction of the Engineer, the full quantity of the security coils will be delivered to the site.

2.09 FINISHES

A. Finish fencing and gates as per the requirements of the Contract Documents and/or applicable Referenced Standards which ever necessary.

PART 3 EXECUTION

3.01 PREPARATION

A. Clear and grub along fence line as required to eliminate growth interfering with alignment. Remove debris from State property.

B. Do not begin installation of fence in areas to be cut until finished grading has been completed.

3.02 INSTALLATION

A. General: Unless specified in the Contract Documents, installation of fences and gates shall be in accordance with the requirements of applicable Referenced Standards.

B. Space posts equidistant in the fence line with a distance not exceeding the specified length on the Drawings or perform in accordance with the requirements of applicable Referenced Standards.

C. Level: The top of the fence shall follow approximately the level of the ground along the line of the fence.

D. Posts and struts: Drill holes for post and struts footings as indicated.
   1. Holes for post and struts shall have vertical sides except that is shall be permissible for the side of the strut hole adjacent to the post be sloped.

E. Locate corner posts at corners and at changes in direction. Use pull posts at all abrupt changes in grade and at intervals as indicated on the Drawings or in accordance with the requirements.

F. Install top rail continuously through post tops or extension arms, bending to radius for curved runs as required. Install expansion couplings as recommended by fencing manufacturers.

G. Brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with horizontal rails as required.

H. Diagonally brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with truss rods and turnbuckles as required.

I. Install gates plumb and level and adjust for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

J. Fence alarm system: Install the inside fence in a manner that will permit satisfactory operation of a fence alarm system. Conform to the requirements of applicable Referenced Standards.

K. Security Coils:
   1. Install security coils in accordance with the requirements of applicable Referenced Standards.
   2. Secure coils to the side of the fence by erecting the material as described for ground installation. Attach each coil loop (or pair of coil loops where adjacent coils are spot welded) to the fence fabric with stainless steel twistable wire ties. The point of attachment shall be made where the security coils are tangent to (intersect) the fence, after it has been expanded to its full length, without tangles and free of distortion. (The location of the point of attachment to the fence will vary as the security coil rotates slightly about its longitudinal axis as it is extended to its full length.)

L. Wire brush and repair welded and abraded areas of galvanized surfaces with one coat of cold galvanizing compound.

M. Restore disturbed ground areas to original condition. Topsoil and seed to match adjacent areas.

END OF SECTION

Effective Date

This Standard Technical Specification shall enter into force as of July 2016.

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Dr. Ambachew Mekonnen, Minister

Ministry of Construction