LEBANESE REPUBLIC

GENERAL DIRECTORATE OF THE PRESIDENCY

PRESIDENTIAL PALACE COMPOUND — BAABDA

REHABILITATION OF MAIN ELECTRICAL ROOM & NEW GENERATORS ROOM

IN THE PRESIDENTIAL PALACE

TENDER DOCUMENTS

Technical Specifications

Unpriced Bill of Quantities

Drawings

PROJECT REFERENCE L2026-14/2026

SOURCE DOCUMENT REVISION R1 | OCTOBER 2026

Consolidated technical document set

9 source files • Original pages and drawing sizes retained

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L2026-14/2026 | Consolidated technical document set

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TENDER DOCUMENTS

VOLUME 2

TECHNICAL SPECIFICATIONS

CIVIL, STRUCTURE AND ARCHITECTURAL – R1

L2026-14/2026

Prepared by

October - 2026

SPECTRUM ENGINEERING CONSULTANTS S.A.R.L.

ISO 9001:2000

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

VOLUME 2 : TECHNICAL SPECIFICATIONS

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Summary of the Works

SECTION 011100
SUMMARY OF THE WORKS

Part 1 - GENERAL

1.01 SECTION INCLUDES

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

1.02 INTRODUCTION

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

1.03 LOCATION OF THE SITE

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

1.04 SCOPE OF WORK FOR THIS CONTRACT

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

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

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

Existing Electrical Room Rehabilitation:

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

New Generator Room:

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

1.05 WORK PERFORMED UNDER OTHER CONTRACTS

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

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

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

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

1.06 PROGRAMME

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

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

1.07 WORK SEQUENCE/PHASES IF ANY

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

1.08 SITE WORK WITH EXISTING CONDITIONS

A. Contractor's use of Site

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

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

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

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

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

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

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

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

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

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

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

B. Reinstatement of Surfaces

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

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

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

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

C. Utility Replacement

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

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

D. Materials

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

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

3. See appropriate sections within the technical specifications.

E. Execution

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

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

1.09 SPECIAL CONDITIONS

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

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

1.10 VALUE ENGINEERING

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

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

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

1.11 INTERCHANGEABLE TERMS

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

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

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

1.12 WORKING IN PARTNERSHIP

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

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

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

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

Payment Procedures

SECTION 012900
PAYMENT PROCEDURES

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 APPLICATIONS FOR PAYMENT

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

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

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

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

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

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

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

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

Project Meetings

SECTION 013110
PROJECT MEETINGS

Part 1 - GENERAL

1.01 SUMMARY

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

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

1.02 PRE-CONSTRUCTION CONFERENCE

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

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

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

1.03 PRE-INSTALLATION CONFERENCES

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

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

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

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

1.04 PROGRESS AND COORDINATION MEETINGS

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

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

1.05 SUBCONTRACTOR'S SITE MEETINGS

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

1.06 TOP TEAM MEETINGS

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

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

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

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

1.07 MINUTES OF MEETINGS

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

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

Electrical Coordinator with Existing Installation

SECTION 013140
ELECTRICAL COORDINATORS WITH EXISTING INSTALLATION

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 ELECTRICAL WORK COORDINATORS

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

1.03 SUBMITTALS FOR REVIEW

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

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

C. All other tasks necessary.

1.04 COORDINATION REQUIRED

A. Coordinate electrical work of the related divisions

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

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

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

E. All other tasks necessary.

1.05 COORDINATION DOCUMENTS

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

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

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

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

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

F. All other tasks necessary.

1.06 COORDINATION OF SUBMITTALS

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

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

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

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

E. Coordinate wiring and control diagrams.

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

G. Verify information and coordinate maintenance of record documents.

H. All other tasks necessary.

1.07 COORDINATION OF SUBSTITUTIONS AND MODIFICATIONS

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

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

C. Submit with recommendation for action.

D. All other tasks necessary.

1.08 OBSERVATION OF WORK

A. Observe Work for compliance with Contract Documents.

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

1.09 DOCUMENTATION

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

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

C. Submit copies of documentation to ENGINEER upon request.

D. All other tasks necessary.

1.10 EQUIPMENT START-UP

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

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

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

D. All other tasks necessary.

1.11 INSPECTION AND ACCEPTANCE OF EQUIPMENT

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

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

C. All other tasks necessary.

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

Scheduling of Construction

SECTION 013260
SCHEDULING OF CONSTRUCTION

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

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

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

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

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

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

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

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

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

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

1.03 CPM SCHEDULE REQUIREMENTS

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

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

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

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

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

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

1.04 QUALITY ASSURANCE

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

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

1.05 CONTRACTORS CONSTRUCTION SCHEDULE DEVELOPMENT

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

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

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

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

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

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

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

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

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

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

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

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

1.06 UPDATING OF CONSTRUCTION SCHEDULE

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

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

1.07 ADJUSTMENT AND REVISIONS

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

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

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

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

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

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

1.08 SCHEDULING SYSTEM

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

1.09 SUBMITTALS

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

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

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

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

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

Submittal Requirements

SECTION 013290
SUBMITTAL REQUIREMENTS

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

Part 1 - GENERAL

1.01 INTRODUCTION

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

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

1.02 TECHNICAL PROPOSAL

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

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

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

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

1.03 TECHNICAL CAPABILITY

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

1.04 ORGANIZATION CHART

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

1.05 METHODOLOGY

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

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

1.06 WORK PROGRAM FOR EXECUTION

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

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

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

1.07 SPECIALIST SUB-CONTRACTORS

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

1.08 CURRICULUM VITAE

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

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

1.09 CONSTRUCTION COST

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

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

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

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

1.10 MAINTENANCE DURING DEFECT LIABILITY PERIOD COST

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

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

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

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

Part 1 - GENERAL

1.01 SUMMARY

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

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

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

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

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

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

1.02 DEFINITIONS

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

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

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

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

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

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

1.03 SHOP DRAWINGS

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

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

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

1.04 PRODUCT DATA

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

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

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

1.05 SAMPLES

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

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

1.06 QUALITY ASSURANCE SUBMITTALS

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

1.07 RECORD DRAWING

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

1.08 AS BUILT DRAWINGS

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

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

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

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

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

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

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

1.09 COMPOSITE DRAWINGS

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

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

Temporary Barriers and Enclosures

SECTION 015600
TEMPORARY BARRIERS AND ENCLOSURES

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 SYSTEM DESCRIPTION

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

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

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

1.03 SUBMITTALS

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

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

C. Obtain ENGINEER approval and approvals of Client.

1.04 QUALITY ASSURANCE

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

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

Part 2 - PRODUCTS

2.01 MATERIALS

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

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

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

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

Part 3 - EXECUTION

3.01 INSTALLATION

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

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

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

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

3.02 MAINTENANCE

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

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

3.03 REMOVAL

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

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

Product Substitution Procedures

SECTION 016300
PRODUCT SUBSTITUTION PROCEDURES

Part 1 - GENERAL

1.01 SUMMARY

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

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

1.02 DEFINITIONS

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

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

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

1.03 SUBMITTALS

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

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

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

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

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

Part 2 - PRODUCTS

2.01 ALTERNATIVE AND SUBSTITUTIONS

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

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

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

Field Engineering

SECTION 017220
FIELD ENGINEERING

Part 1 - GENERAL

1.01 SUMMARY

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

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

1.02 REFERENCES

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

1.03 SUBMITTALS

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

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

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

1.04 QUALITY ASSURANCE

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

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

1.05 PROJECT RECORD DOCUMENTS

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

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

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

Part 2 - EXECUTION

2.01 INSPECTION

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

2.02 GENERAL

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

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

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

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

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

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

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

2.03 SURVEY REFERENCE POINTS

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

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

2.04 SURVEY REQUIREMENTS

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

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

C. Periodically verify layouts by same means.

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

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

2.05 LAYING OUT

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

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

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

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

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

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

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

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

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

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

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

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

Final Cleaning

SECTION 017410
FINAL CLEANING

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 DESCRIPTION

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

1.03 QUALITY ASSURANCE

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

Part 2 - PRODUCTS

2.01 CLEANING MATERIALS

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

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

Part 3 - EXECUTION

3.01 FINAL CLEANING

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

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

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

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

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

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

F. Clean surfaces of equipment; remove excess lubrication.

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

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

I. Clean light fixtures and lamps.

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

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

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

3.02 DEEP CLEANING

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

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

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

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

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

Operation and Maintenance Data

SECTION 018300
OPERATIONAL MAINTENANCE DATA

Part 1 - GENERAL

1.01 SUMMARY

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

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

1.02 QUALITY ASSURANCE

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

1.03 FORMAT

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

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

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

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

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

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

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

1.04 CONTENTS, EACH VOLUME

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

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

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

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

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

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

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

1.05 MANUAL FOR MATERIALS AND FINISHES

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

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

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

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

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

1.06 MANUAL FOR EQUIPMENT AND SYSTEMS

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

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

C. Include as-installed color coded wiring diagrams.

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

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

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

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

H. Include sequence of operation by controls manufacturer.

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

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

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

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

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

N. Include description of each system.

O. Include test, balancing and commissioning report.

P. Include factory inspection and test certificate.

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

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

S. Photocopies of Warranties.

1.07 SUBMITTALS

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

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

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

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

Structure Demolition

SECTION 024116
STRUCTURE DEMOLITION

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

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

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

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

1.03 MATERIALS OWNERSHIP

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

1.04 SUBMITTALS

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

B. Proposed dust-control measures.

C. Proposed noise-control measures.

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

E. Inventory of items to be removed and salvaged.

F. Inventory of items to be removed by Employer.

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

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

1.05 QUALITY ASSURANCE

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

Part 2 - PRODUCTS

2.01 SOIL MATERIALS

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

Part 3 - EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and capped.

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

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

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

3.02 UTILITY SERVICES

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

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

3.03 PREPARATION

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

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

3.04 EXPLOSIVES

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

3.05 POLLUTION CONTROLS

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

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

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

3.06 DEMOLITION

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

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

3.07 DISPOSAL OF DEMOLISHED MATERIALS

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

B. Burning: Do not burn demolished materials.

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

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

3.08 PROTECTION

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

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

Site Preparation

SECTION 024200
SITE PREPARATION

Part 1 - GENERAL

1.01 SUMMARY

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

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

1.02 QUALITY ASSURANCE

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

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

1.03 SUBMITTALS

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

1.04 PROJECT CONDITIONS

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

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

Part 2 - PRODUCTS - Not used

Part 3 - EXECUTION

3.01 CLEARING

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

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

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

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

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

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

3.02 PROTECTION

A. Protect bench marks from damage or displacement.

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

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

Earth Moving

SECTION 024250
EARTH MOVING

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

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

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

1.03 SUBMITTALS

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

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

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

1.04 QUALITY ASSURANCE

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

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

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

1.05 PROJECT CONDITIONS

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

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

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

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

Part 2 - PRODUCTS

2.01 MATERIALS

A. Structural Fill

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

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

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

B. Ordinary Fill

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

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

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

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

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

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

2.02 ACCESSORIES

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

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

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

Part 3 - EXECUTION

3.01 EXCAVATION

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

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

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

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

         i) Under paved areas and kerbs: 95%

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

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

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

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

3.02 FILLING AND COMPACTING

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

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

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

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

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

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

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

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

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

3.03 FIELD QUALITY CONTROL

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

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

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

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

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

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

3.04 STORAGE AND DISPOSAL OF EXCAVATED MATERIALS

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

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

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

3.05 PROTECTION

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

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

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

Shoring

SECTION 024300
SHORING

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 SHORING SYSTEM DESIGN

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

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

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

1.03 SUBMITTALS

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

1.04 QUALITY ASSURANCE

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

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

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

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

1.05 PROJECT CONDITIONS

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

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

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

Part 2 - PRODUCTS

2.01 MATERIALS

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

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

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

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

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

Part 3 - EXECUTION

3.01 SHORING

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

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

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

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

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

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

Concrete Accessories

SECTION 031500
CONCRETE ACCESSORIES

Part 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

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

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

1.03 SYSTEM DESCRIPTION

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

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

1.04 SUBMITTALS

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

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

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

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE AND HANDLING

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

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

1.07 WARRANTY

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

Part 2 - PRODUCTS

2.01 MANUFACTURES

A. Water Stops

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

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

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

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

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

6. Or approved equal

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

2.02 MATERIALS

A. Water Stops

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

Part 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

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

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

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

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

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

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

G. Replace damaged water stops before concreting.

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

3.03 PROTECTION

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

Cast- in- Place Concrete

SECTION 033000
CAST-IN-PLACE CONCRETE

Part 1 - GENERAL

1.01 SUMMARY

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

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

1.02 REFERENCES

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

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

B. British Standards Institute (BSI)

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

C. American Concrete Institute (ACI)

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

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

1.03 SYSTEM DESCRIPTION

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

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

1.04 SUBMITTALS

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

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

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

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

D. Certifications for Admixtures: As specified under admixtures.

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

1.05 QUALITY ASSURANCE

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

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

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

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

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

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

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

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

C. Plant and Field Tests and Inspection

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

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

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

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

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

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

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

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

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

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

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

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

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

E. Testing Plan:

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

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

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

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

Part 2 - PRODUCTS

2.01 MATERIALS

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

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

C. Aggregate

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

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

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

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

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

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

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

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

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

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

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

D. Water

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

E. Admixtures

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

F. Reinforcement

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

G. Bar Supports

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

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

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

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

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

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

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

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

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

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

2.02 MIXES

A. Proportioning of Concrete

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

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

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

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

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

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

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

B. Classes of Concrete

1. Schedule of Concrete Types

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

General Important Notes

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

Part 3 - EXECUTION

3.01 FORMWORK

A. General

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

B. Workmanship

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

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

3.02 REINFORCEMENT

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

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

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

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

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

3.03 MIXING CONCRETE

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

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

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

C. Hand Mixed Concrete: This is not permitted.

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

3.04 PLACING CONCRETE

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

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

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

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

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

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

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

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

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

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

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

3.05 CURING

A. General

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

B. Curing Methods

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

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

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

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

3.06 STRIKING OF FORMWORK

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

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

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

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

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

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

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

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

3.07 TOLERANCES

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

3.08 CLEANING FINISHED EXPOSED CONCRETE SURFACES

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

3.09 PATCHING

A. Comply with ACI 301, Chapter 9.

3.10 FINISHING

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

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

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

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

1. Membrane Waterproofing.

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

1. Floor beds.

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

1. Driveway, Ramps and Parking.

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

Metal Fabrication

SECTION 055000
METAL FABRICATIONS

Part 1 - GENERAL

1.01 SUMMARY

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

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

1.02 PERFORMANCE REQUIREMENTS

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

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

1.03 SUBMITTALS

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

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

1.04 QUALITY ASSURANCE

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

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

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

1.05 PROJECT CONDITIONS

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

1.06 COORDINATION

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

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

Part 2 - PRODUCTS

2.01 MATERIALS

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

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

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

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

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

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

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

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

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

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

2.02 OTHER MATERIALS

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

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

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

2.03 FABRICATION, GENERAL

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

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

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

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

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

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

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

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

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

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

2.04 MISCELLANEOUS FRAMING AND SUPPORTS

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

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

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

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

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

F. All structural elements to comply with ASTM A572

G. All bolts to be grade (8.8)

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

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

J. All welding to by experts

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

L. All fixing bolts to be properly fixed

M. All junctions to match AISC

N. All steel members to be dust free.

2.05 LOOSE BEARING AND LEVELING PLATES

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

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

2.06 STEEL WELD PLATES AND ANGLES

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

2.07 FINISHES

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

B. Finish metal fabrications after assembly.

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

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

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

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

Part 3 - EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION, GENERAL

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

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

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

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

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

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

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

3.03 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

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

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

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

3.04 INSTALLING SAFETY NOSINGS

A. Center nosings on tread widths unless otherwise indicated.

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

3.05 INSTALLING BEARING AND LEVELING PLATES

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

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

3.06 ADJUSTING AND CLEANING

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

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

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

LEBANESE REPUBLIC
GENERAL DIRECTORATE OF THE PRESIDENCY
PRESIDENTIAL PALACE COMPOUND- BAABDA

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

TENDER DOCUMENTS

VOLUME 2

TECHNICAL SPECIFICATIONS

MECHANICAL ENGINEERING SERVICES - R1

L2026-14/2026

Prepared by

October - 2026

SPECTRUM ENGINEERING CONSULTANTS S.A.R.L.
ISO 9001:2000

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

VOLUME 2 : TECHNICAL SPECIFICATION

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SECTION 211317
FIRE EXTINGUISHERS

SECTION 211317
FIRE EXTINGUISHERS

Part 1 - GENERAL

1.01 SUMMARY

A. Section includes portable, hand-carried fire extinguishers.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.

B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.

C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.03 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10,"Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1.04 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.05 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: To establish a standard of quality, design and function desired, drawings and specifications are based on products by the approved manufacturer.

B. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following manufacturers:
   1. Naffco
   2. SFFECO
   3. ANSUL
   4. MOBIAK S.A.
   Or approved equal

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. PFE-6KG Dry Chemical Portable Fire Extinguisher

6 kg store-pressure ABC dry chemical portable fire extinguisher, suitable for Class A,B and C fires, complete with steel cylinder, pressure gauge, discharge hose, wall mounting bracket, safety pin, and tamper seal. UL/FM listed and manufactured in accordance with NFPA 10.

B. PFE-5KG CO_2 Portable Fire Extinguisher

5kg carbon dioxide (CO_2) portable fire extinguisher, suitable for Class B and electrically energized (Class C) fires, complete with seamless steel cylinder, discharge horn, wall mounting bracket, safety pin, and tamper seal. UL/FM listed and manufactured in accordance with NFPA 10.

C. PFE-6L Foam Portable Fire Extinguisher

6L stored-pressure foam portable fire extinguisher, suitable for Class A and B fires, complete with steel cylinder, pressure gauge, discharge hose/nozzle, wall mounting bracket, safety pin, and tamper seal. UL/FM listed and manufactured in accordance with NFPA 10.

2.03 ACCESSORIES

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

Part 3 - EXECUTION

3.01 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.02 INSTALLATION

A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

SECTION 212200
CLEAN-AGENT AND FM200 FIRE SUPPRESSION

SECTION 212200
CLEAN-AGENT AND FM200 FIRE SUPPRESSION

Part 1 - GENERAL

1.01 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 21 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Piping and piping specialties.
2. Extinguishing-agent containers.
3. Extinguishing agent.
4. Detection and alarm devices.
5. Control and alarm panels.
6. Accessories.
7. Connection devices for and wiring between system components.
8. Connection devices for power and integration into building's fire-alarm system.

1.03 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. EPO: Emergency Power Off.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
1. Product Data for Credit EA 4: Documentation indicating that clean agents comply.

C. Shop Drawings: For FM200 clean-agent fire-extinguishing system signed and sealed by a qualified professional engineer.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include design calculations.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Wiring Diagrams: For power, signal, and control wiring.
   Delegated-Design Submittal: For clean-agent fire-extinguishing system signed and sealed by the qualified professional engineer.
5. Indicate compliance with performance requirements and design criteria, including analysis data.
6. Include design calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
7. Indicate the Following on Reflected Ceiling Plans:
   a. Ceiling penetrations and ceiling-mounted items.
   b. Extinguishing-agent containers if mounted above floor, piping and discharge nozzles, detectors, and accessories.
   c. Method of attaching hangers to building structure.
   d. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
8. Indicate the Following on Occupied Work Area Plans:
   a. Controls and alarms.
   b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
   c. Equipment and furnishings.
9. Indicate the Following on Access Floor Space Plans:
   a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
   b. Method of supporting piping.
10. Indicate the Following on Ceiling Plans:
    a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
    b. Method of supporting piping.
    c. Other equipment located in the ceiling space that is being protected including sprinkler piping, HVAC equipment, raceways, or conduit.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Domestic water piping.
   2. Items Penetrating Finished Ceiling Include the Following:
      a. Lighting fixtures.
      b. Air outlets and inlets.

E. Permit Approved Drawings: Working plans, prepared according to NFPA 2001, that have been approved by authorities having jurisdiction. Include design calculations.

F. Field quality-control reports.

G. Operation and Maintenance Data: For special agent system to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Global's "Approval Guide."

C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

D. Comply to latest Civil Defense Department regulations.

1.06 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
   1. Detection Devices: Not less than 20 percent of amount of each type installed.
   2. Container Valves: Not less than 10 percent of amount of each size and type installed.
   3. Nozzles: Not less than 20 percent of amount of each type installed.
   4. Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.07 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 CLEAN-AGENT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. Ansul Incorporated.
   2. Chemetron Fire Systems.
   3. Fike Corporation.
   4. Pyro-Chem.
   5. Tyco Safety Products Group.
   6. LPG Group of Companies.
   Or approved equal

C. Description: Clean-agent fire-extinguishing system FM200 shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the under floor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.

D. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

E. Performance Requirements: Discharge HFC 227ea within 10 seconds and maintain 7.1 percent concentration by volume at 70 deg F (21 deg C) for 10-minute holding time in hazard areas.
   1. HFC 227ea concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 6.5 percent throughout holding time will not be accepted without written authorization from Client and authorities having jurisdiction.

F. Performance Requirements: Discharge IG-541 within 60 seconds and maintain 38 percent concentration by volume at 70 deg F (21 deg C) for 10-minute holding time in hazard areas.

G. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in other zone.

H. Verified Detection: Devices located in single zone. Sound alarm on activating single detection device, and discharge extinguishing agent on actuating second-detection device.

I. System Operating Sequence:
   1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
   2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent.

   3. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.

J. Manual stations shall immediately discharge extinguishing agent when activated.

K. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release of hand pressure on the switch will cause agent discharge if the time delay has expired.

L. EPO: Will terminate power to protected equipment immediately on actuation.

M. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.

N. Power Transfer Switch: Transfer from normal to stand-by power source.

2.02 FM200 AUTOMATIC FIRE PROTECTION SYSTEM:

A. General: Supply and install FM200 automatic fire protection system wherever shown on drawings and as specified herein.

Provide fixed total flooding FM200 fire extinguishing system and Companion fire detection system for protection of rooms as shown on drawings.

Each system to include main and reserve banks of FM200 cylinders feeding common manifold from which piping of suitable size is to run to discharge nozzles. Transfer from main to reserve bank is to be by an electric switch.

Detectors be cross-zoned in each protected space and lead back to status panel. Each system to be two-zone controlled. Actuation of any detector is to indicate a first stage alarm condition on status panel and intermittently operate audio-visual alarm unit. Actuation of any two detectors, one per zone, is to indicate a fire condition in both zones of status panel, give continuous audio-visual alarm and after a preset discharge delay, energize FM200 operating switch-leg up to discharge delay. Detection system is to include voltage-free contacts for shut down of mechanical equipment during count-down of discharge delay.

Discharge of FM200 may be aborted during discharge delay period by holding in a lock-off switch located in status panel. Time delay device to be adjustable from 5 to 60 seconds.

System not aborted: After delay period, solenoid type control heads on main cylinders are to operate and release FM200. At the same time, pressure operated switch and pressure operated trips are to control closing of doors and ventilation shutters to prevent loss of FM200 after being discharged.

Pressure operated trips: To be fed from discharge nozzle tees by 15mm diameter line.

Pressure operated switch: To be fed from the discharge header by 15mm diameter line.

Auxiliary manual discharge operation is to be provided through remote electric switch case or through manually operated non-electric levers on cylinder control heads. Either means to be arranged to by-pass discharge delay and abort circuitry.

Entire storage and distribution system is to completely discharge FM200 into hazard space within 10 seconds after FM200 appears at discharge nozzles.

Design system in accordance with BS or NFPA and totally flood the hazard areas. Concentration to be as per requirements for deep-seated fires.

Materials and equipment to be first grade, standard current products of manufacturer, suitable for performance of their separate functions and to

conform to Underwriter's Laboratories Inc., of Factory Mutual System requirements, or UK equivalent.

Cylinder assemblies to be filled in accordance with the requirements of BS or NFPA.

Flow calculations are to provided to prove integrity of pipe and nozzle sizes. Calculations are to include dimensions and volume of room, design temperature, FM200 volume factor, required quantity, size and fill weight of cylinders, volumetric concentration, discharge time, flow rate per nozzle, type of nozzle, pipe sizes, nozzle thread and orifice sizes. Allowance for non-closable.
Pipes: Galvanized steel, seamless.
Fittings: Galvanized, 20 bars (300 psi), malleable iron pressure type.
Manifold: Fabricate from standard weight galvanized steel pipe and galvanized fittings.

Piping joints: To the requirements of BS or NFPA.
Bushings: Hex steel and limited to reductions of not more than two pipe sizes.
Extinguishing agent: FM200 (HFC 227 ea)

B. Storage Cylinders: Shall be floor standing type, constructed of high strength steel alloy conforming to all applicable specifications of the U.S. Department of Transportation. Containers – Hazardous Materials or equal approved authority. Mount in an upright position and hold securely in steel racks with clamps or straps. Each cylinder to have a discharge valve. Connect cylinders to manifold with non-metallic tubing through check valve to prevent FM200 loss during discharge.

C. Reserve cylinders: shall be filled identically to main cylinders, of equal quantity and continued on same rack. Reserve bank to duplicate all functions of main bank.

D. Racks: shall be type allowing any cylinder to be weighed without removing it from framework and without putting system out service. Racks to be complete with clamps, weigh bars and all other items necessary to provide a complete installation. Provide scales and scale beams (ratio 10 to 1).

E. Cylinder discharge valve: shall operate by differential force using cylinder pressure as source. Force differential and metallic spring are to hold valve closed prior to discharge and to reverse upon actuation to open the valve. Reversal is to be by venting agent through an opening on cylinder valve. Discharge to be not less than 90-95% by weight of FM200.

F. Discharge nozzles: shall be multi-jet type of corrosion resistant brass construction, finished with protective coating and with female threaded connection, complete with blow-off cover. Nozzle to be threaded directly to piping without use of special adaptors.

G. Detection system: each to be fully supervised type in which any trouble within system causes common trouble buzzer to sound and trouble lamp to light on control panel. Silence switch is to be provided to silence trouble buzzer. Trouble zone lamps are to remain lit until trouble is cleared. Each zone to

have its own trouble lamp. Ring back feature is to sound trouble buzzer after trouble is cleared if silence switch is in silence position. Common alarm buzzer and alarm silence switches are to be provided for each zone.

H. Hazard alarm: shall be included in detection system and having outstanding sound level and distinctive tone to warn of hazardous condition and possible FM200 discharge.

2.03 PIPING MATERIALS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.

2.04 PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Grade B or ASTM A 106/A 106M, Grade A; Schedule 40,Schedule 80, and Schedule 160, seamless steel pipe.
   1. Threaded Fittings:
      a. Malleable-Iron Fittings: ASME B16.3, Class 300.
      b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
      c. Fittings Working Pressure: 620 psig (4278 kPa) minimum.
      d. Flanged Joints: Class 300 minimum.
   2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
   3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Steel, Keyed Couplings: UL 213, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.05 VALVES

A. General Valve Requirements:
   1. UL listed or FM Approved for use in fire-protection systems.
   2. Compatible with type of clean agent used.

B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.06 DISCHARGE NOZZLES

A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.

2.07 MANIFOLD AND ORIFICE UNIONS

A. Description: NRTL-listed device with minimum 2175-psig (15-MPa) pressure rating.

1. NPS 2 (DN 50) and Smaller: Piping assembly with orifice, sized for system design requirements.
2. NPS 2-1/2 (DN 65) and Larger: Piping assembly with nipple, sized for system design requirements.

2.08 CONTROL PANELS

A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.

B. Power Requirements: 240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
1. Mounting: Recessed flush with surface.

D. Supervised Circuits: Separate circuits for each independent hazard area.

1. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
2. Manual pull-station circuit.
3. Alarm circuit.
4. Release circuit.
5. Abort circuit.
6. EPO circuit.

E. Control-Panel Features:
1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.

F. Standby Power: Sealed lead calcium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.09 DETECTION DEVICES

A. General Requirements for Detection Devices:
   1. Comply with NFPA 2001, NFPA 72, and UL 268.
   2. 24-V dc, nominal.

B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

D. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.

E. Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

2.10 MANUAL STATIONS

A. General Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 240-V ac or low voltage compatible with controls. Include contacts for connection to control panel.

B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
   1. Abort Switch: "ABORT" caption, momentary contact, with green finish.
   2. EPO Switch: "EPO" caption, with yellow finish.

2.11SWITCHES

A. Description: FM Approved or NRTL listed, where available, 240-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
   1. Low-Agent Pressure Switches: Pneumatic operation.
   2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
   3. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.12ALARM DEVICES

A. Description: Listed and labeled by an NRTL or FM Approved, low voltage, and surface mounting. Comply with requirements in Division 28 Section "Digital, Addressable Fire-Alarm System" or Division 28 Section "Zoned (DC Loop) Fire-Alarm System" for alarm and monitoring devices.

B. Bells: Minimum 6-inch (150-mm) diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

2.13ELECTRICAL POWER AND WIRING

A. Electrical power, wiring, and devices are specified in other Division.

Part 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.

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

3.02 HFC 227EA AGENT PIPING APPLICATIONS

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. NPS 2 (DN 50) and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

C. NPS 2-1/2 (DN 65) and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

3.03 CLEAN-AGENT PIPING INSTALLATION

A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.

B. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.

C. Install extinguishing-agent containers anchored to substrate.

D. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001, Section "Distribution."
   1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
   2. Support piping using supports and methods according to NFPA 13.
   3. Install seismic restraints for extinguishing-agent containers and piping systems.
   4. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.04 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in other Division.

3.05 IDENTIFICATION

A. Identify system components and equipment. Comply with requirements for identification specified in other Division 26 Section for Electrical Systems.

B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.

C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.

D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space in two different languages.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
   3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
   5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Arrange Civil Defense Department visit to site test, demonstrate the system for their approval.

F. Units will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.07 CLEANING

A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

3.08 SYSTEM FILLING

A. Preparation:
   1. Verify that piping system installation is completed and cleaned.
   2. Check for complete enclosure integrity.
   3. Check operation of ventilation and exhaust systems.
B. Filling Procedures:
   1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
   2. Install filled extinguishing-agent containers.
   3. Energize circuits.
   4. Adjust operating controls.

3.09DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire extinguishing systems.

SECTION 220000
PLUMBING FACILITIES

SECTION 220000
PLUMBING FACILITIES

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Complete Plumbing System in accordance with the requirements of the Contract Documents, work includes:
   1. Service connections to external utilities.
   2. Domestic cold water supply system.
   3. Domestic hot water supply system.
   4. Soil, waste and vent system.
   5. Storm water drainage system.
   6. Sanitary fixtures.
   7. Plumbing equipment.
   8. Plumbing specialties
   9. General duty valves.

1.02 SYSTEM DESCRIPTION

A. System Performance:
   1. The Contractor shall guarantee that all elements of the system are of sufficient capacity to meet the performance requirements stipulated in or implied by the Contract Documents.

B. Design Requirements:
   1. All the system components shall be of the type and construction, capable of withstanding the water and ambient conditions and shall be resistant to deterioration from high incidence of ultra violet rays.

   2. Electrical Enclosures: All electrical enclosures such as control panels, pump motors, etc., shall be rated at IP54 unless otherwise stated. Each and every control panel shall have its own disconnect switch or be provided with a local isolator adjacent to the panel so as to isolate the power supply during maintenance. All knockouts for the cable entries shall be at the bottom of the panels.
   3. General Stipulations:
      a. The Contractor shall allow in his Tender for making all connections to existing services and shall submit details and drawings of each connection to the Engineer for his prior approval.
      b. The Contract Drawings show the various piping systems schematically. Tenderers shall satisfy themselves that the layouts shown accurately represent the existing conditions and no added compensation will be permitted for any work due to want of Knowledge in this respect.
      c. Furnish all sleeves for passage of pipes through structural masonry and concrete walls and floors and elsewhere as will be required for the proper protection of each pipe.
      d. Check the existence of any service, surface or sub-surface structure in the vicinity of the work. Do not disturb or damage any of these services or structures and make necessary provisions by shoring or other means

in order to avoid damaging these services or structures. Repair any damage immediately.

e. Carefully examine the structural, HVAC and electrical drawings to avert possible installation conflicts.
f. Submit to the Engineer shop drawings covering all items of work under this Contract. No work shall be carried out until the shop drawings have been approved by the Engineer Reproduction of Contract Drawings by the Contractor shall not be acceptable as shop drawings.

1.03 SUBMITTALS

A. General: All submissions for approval shall be submitted sufficiently in advance of requirements to allow the Engineer ample time for checking and approving. These clauses are in addition to the contract requirements.

B. Samples: Submit samples, as requested by the Engineer of all materials and equipment specified herein in accordance with the requirements of the Contract Documents and before ordering obtain written approval from the Engineer. All samples shall be properly tagged when submitted for approval.

C. Product Data:
1. Manufacturer's Data: Prior to the submission of shop drawings, submit to the Engineer full details, specifications, installation instructions, tc., of all materials and equipment proposed for use but in all cases no such materials/equipment shall be ordered, delivered or installed without the prior written approval of the Engineer to the Contractor's shop drawings incorporating the said materials/equipment. Any material or equipment which is not approved but installed shall be removed and replaced at the Contractor's expense.
2. The details of materials and equipment shall include the following:
    a. Full technical specifications of equipment including construction, materials, degree of protection, characteristic curves, test and performance certificates of equipment, diagrams, capacities, rating, dimensions, fixing details, etc.
    b. Relevant sheets of manufacturers' catalogues, specifications, technical data, etc.
    c. The estimated current consumption and heat dissipation of any equipment proposed.
    d. Maintenance and supervisory statistics as approved by others for similar systems.
3. At the time of providing the above details submit a statement from manufacturer to the effect that the proposed materials, equipment and systems' performance and functions comply fully with the relevant Clauses of the Specification and, in case of deviation from the Specification, submit a schedule of deviations listing all points not conforming to the Specification.
4. At the same time submit a preliminary time schedule to indicate all logistical elements (i.e. design, submission for approved, ordering, shipping, delivery, installation, etc.).

D. Shop Drawings:
1. General external piping layout drawings to a scale not smaller than 1:100.

2. Equipment installation and piping layout, double line drawings off toilets, bathrooms, kitchens, plant rooms, sump pumps, etc. Clearly indicating all fittings, supports, valves etc. to a scale of 1:20. Submit sections and wall elevations as appropriate.
3. Typical floor plans indicating shafts, risers locations etc. to a scale of 1:50.
4. Builder's work layout plans to a scale of 1:100/1:50 as above along with shaft detail plans to 1:10.
5. Assemblies like pressure reducing valves and items of similar nature to a scale of 1:10.
6. Vacuum breakers, hydrants, air release valves, sleeves and penetrations, all types of drains and clean outs, etc. to a scale of 1:5.
7. Equipment like filters and items of similar nature to a scale of 1:20.
8. Electrical wiring diagrams (NTS) and panel installation details (1:20).
9. Calculations / details to substantiate the shop drawings.

E. Progress record Drawings: Submit project record documents of all works installed under this section, in accordance with the following:
   1. Furnish and keep on the job at all times one complete and separate set of black-line prints of the plumbing work on which shall be clearly, neatly and accurately noted, promptly as the work progresses all plumbing changes, revisions and additions to work as actually installed. Wherever work is installed other than as shown on the Contract Drawings, such changes shall be noted.
   2. Indicate daily progress on progress prints by colouring in the various pipes, fixtures, apparatus and associated attachments as they are erected.
   3. No approval for payment of work installed will be given unless supported by coloured-up record prints as required above.

F. "As-built" Drawings:
   1. At the conclusion of work, prepare and submit "as-built" Drawings prepared from the latest progress prints.
   2. Contractor shall prepare as-built drawings and submit and obtain approval for the respective services. Necessary follow-up, calculations shall be submitted by the Contractor as required by these authorities.
   3. In addition, submit sets of CD's of all "as-built" drawings.

G. Operation and Maintenance Instruction Manuals
   1. At the time of submitting "as-built" drawings, provide the Engineer with three properly printed and bound copies of operation and maintenance instruction manuals for each system of Plumbing Work to describe the various systems in the fullest detail to facilitate the proper operation, maintenance, replacement of parts and awareness of system characteristics and complete building systems description.

1.04 QUALITY ASSURANCE

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

B. Installer Qualifications: The plumbing work shall be executed by an approved Specialist Contractor having minimum 10 years experience in similar type of works.

C. Regulatory Requirements:

1. Ensure that, where applicable, the work and any materials used in the execution of the work in accordance with the Contract, comply with the requirements of the particular Public Authority having jurisdiction.
2. Where necessary to comply with regulations, inform the Public Authority of the proposed work and obtain from them any written approval that may be required.
3. Submit to the Public Authority any materials for testing that the Authority may require. Provide the Engineer with a copy of all correspondence, test certificates, etc., in connection with the works.
4. Comply with the relevant requirements of the National Plumbing Code.

1.05 MAINTENANCE

A. Operation and Maintenance:
1. Include for Operation, Routine Maintenance and Preventive Maintenance commencing from testing and commissioning until the end of the Contract Defect's Liability Period of 2 years from the date of Substantial Completion with requirements of Contract Documents as follows:
    a. Defect liability/breakdown maintenance, inclusive of replacement parts.
    b. Preventive maintenance as scheduled, inclusive of replacement parts and consumables.
    c. Operation of all systems.
    d. Attending to emergency situations, which may damage property or endanger lives, even outside normal working hours.
    e. Provide a written report to the Employer, detailing the maintenance work performed; including dates, parts replaced etc.
    f. The Employer's personnel shall be allowed to witness or participate (without damageous interference) in the above activities.
2. Provide all necessary operation and maintenance staff experienced in both mechanical and electrical work such as engineer on-call basis, one foreman, one plumber (experienced in plumbing and electrical works) with helpers, etc., for effective maintenance of all systems. Submit to the Engineer for approval qualification details of all maintenance staff.
3. The Contractor shall note that during the Defect's Liability Period, rapid response to calls for attendance on-site may be necessary. It may, therefore, be necessary, at times, for the Contractor to undertake repairs to defective Contract Works outside normal working hours. Include all routine and preventive scheduled maintenance as recommended by the equipment manufacturers to keep plant and pipework in perfect operating condition.
4. The minimum staff/supervision required for operation and maintenance shall be employed during the Defect's Liability Period.
5. Submit a maintenance schedule for approval by the Engineer.
6. Keep all records, log books, log sheets, maintenance job cards, etc., in neat order to the satisfaction of the Engineer. All records, log books, and log sheets, charts, maintenance job cards, etc., shall become the property of the Employer.
7. During the Defect's Liability Period control, maintain, replace and repair any part of equipment or material within the systems which may prove defective due to Contractor's design, erection, performance, or workmanship, or prove defective from any act or omission that may develop from use in the Works or any section thereof. Defective is hereby defined to include, but not limited to operation or control system failures, Performances below required minimum, excessive wear, unusual deterioration or aging of materials or finishes,

unsafe conditions, the need of excessive maintenance, abnormal noise or vibration and similar unusual, unexpected and unsatisfactory conditions.

8. Provide all spare parts for replacements made necessary due to wear and tear of equipment. Provide all consumable parts, short life parts, oils, etc., and all tools and maintenance equipment required for proper complete maintenance of the Works.
9. Provide all routine operational maintenance and full preventive maintenance as recommended by the equipment manufacturers to keep equipment and systems in proper operating condition.
10. Provide the routine operational maintenance activities and full preventive maintenance procedures relating to the systems.
11. Be responsible for training the Employer's personnel selected by the Engineer in the correct operation, control and maintenance of the installations specified herein. Training shall be carried out by qualified commissioning and operating staff of the Contractor.
12. The foregoing Clauses are in addition to and in no way relieve the Contractor of his liabilities and obligations under the Contract.

B. Tools and Maintenance Equipment

1. In addition to the spare parts, tools and maintenance equipment provided by the Contractor pursuant to his obligations to maintain the systems specified herein throughout the Contract Defect's Liability Period, the Contractor shall, prior to completion of the Construction Works, supply the spare parts, tools and maintenance equipment specified herein for use after the expiry of such Defect's Liability Period, and store the same in a location in the building designated by the Engineer. Such specified spare parts, tools and maintenance equipment shall not be used by the Contractor during the period of maintenance unless in an emergency and as expressly authorized by the Engineer.
2. All spare parts, tools and maintenance equipment shall be provided in original packing, clearly labelled and referenced. Provide complete schedules of spare parts and maintenance equipment clearly cross referenced with the "as-built" record drawings and with operation and maintenance instructions manuals.
3. All spare parts, tools and maintenance equipment shall be as recommended by the equipment manufacturer and shall be subject to the final approval of the Engineer.
4. Supply spare parts and maintenance equipment for all plant and pipework systems including valves, controls, filters, sanitary fixtures and like items requiring maintenance and replacement sufficient for a period of two (2) years after the expiry of the Defect's Liability period, unless otherwise stated.
5. Supply one new complete set of tools for the proper operation, routine maintenance and adjustment of all components and equipment.

C. Spare Parts:

1. Spare Parts, Tools and Maintenance Equipment
    a. In addition to the spare parts, tools and maintenance equipment provided by the Contractor pursuant to his obligations to operate and maintain the systems specified herein throughout the Contract Maintenance Period, the Contractor shall prior to completion of the Works, supply the spare parts, tools and maintenance equipment specified herein in the various Sections of the Plumbing & Fire Protection Specifications for use after the expiry of such Maintenance

Period, and store the same in a location in the building designated by the Engineer. Such specified spare parts, tools and maintenance equipment shall not be used by the Contractor during the period of maintenance unless in an emergency and as expressly authorized by the Engineer.

b. All spare parts, tools and maintenance equipment shall be provided in original packing, clearly labeled and referenced. Provide complete schedules of spare parts and maintenance equipment clearly cross referenced with the "as-built" record drawings and with operation and maintenance instructions manuals.
c. All spare parts, tools and maintenance equipment shall be as recommended by the equipment manufacturer and shall be subject to the final approval of the Engineer.
d. Spares and maintenance equipment shall include but not limited to:
    i) Pumps : shafts, shaft sleeves, stuffing boxes, bearings, couplings, gaskets, glands, bushes, Impeller, Mechanical Seal, Wearing Ring, LED Lamp for control panel, Fuses of control panel, Over load protection relay, etc.
    ii) Valves: complete sets of washers, gaskets, packing glands, discs, seating etc. that can be renewed.
    iii) Sanitary Fixtures: Provide Spare sanitary fixtures of at least 2% of total quantity of types of sanitary fixtures with all required waste and water supply fittings as per specifications.
    iv) Plumbing Specialties: Provide spare plumbing specialties of at least 2% of total quantity or 3 Nos. whichever is more of each type of plumbing specialties.
e. The Contractor shall provide with the tender a separate priced list of spare parts recommended for two years duration after the free maintenance period (Defects Liability Period). This spare parts list will be recommended by the manufacturer for fire protection works and valid for a two year period, but whose total cost does not form part of the tender lump sum.
f. If any defect that arises during the maintenance period is not remedied by the Contractor within a reasonable time, the Engineer may arrange for the work to be done at the Contractors expense.
g. Supply two new complete sets of tools complete with lockable tool boxes for the proper operation, routine maintenance and adjustment of all components and equipment.
h. In a room designated by the Engineer provide suitably robust storage racks, shelves, trays, boxes, cupboards, work benches, etc., to store all normally held stocks of spare parts, consumables and all tools, maintenance equipment and accessories specified herein for all electro-mechanical works. Provide a suitable spare parts (card index) inventory system to record the use of such spares and consumables and to facilitate re-stocking requirements and incorporate as data base for the Maintenance Management Program to be provided under Building Automation System.

D. Operation and Maintenance Instruction Manuals: Submit hard bound copies of “Operation and Maintenance Manual”, as built drawings and with complete data for each piece of equipment installed, as detailed below:
    1. Table of contents.

2. Plumbing material submittal with the Engineer's and local authorities approval.
3. Manufacturer's installation instructions.
4. Manufacturer's internal wiring diagrams.
5. Manufacturer's assembly details.
6. Replacement, parts number listings and description.
7. Preventive maintenance schedules listing frequency of service and or replacement.
8. Lubrication materials, equivalents and schedules.
9. Name and addresses of manufacturer, sales and service agency and local representative / distributor including telephone, telex and telefax nos.
10. Names and addresses of Contractor's maintenance department, including emergency contact telephone numbers.
11. Arrange the contents of the manual in sections with tags, grouping each class of equipment as pumps, fixtures, water heaters, filters, controls, etc.
12. Arrange contents of each section in sequence as listed above (Item 2).

1.06 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

Refer to individual section for plumbing materials and equipment.

Part 3 - EXECUTION

3.01 PREPARATION

A. Study all drawings and specifications and familiarize with the structural and architectural details and the work of other trades.

B. Ensure that the work under this section will not interfere with those of other trades and are compatible with the architectural finishes, prior to placing orders, fabrication and installation.

C. Coordinate with the electrical works for the exact power requirements and location and type of the interface. Furnish all information as required by the Client for obtaining approvals.

D. Furnish necessary templates, patterns, setting out plans and other items for incorporation in the works or for leaving necessary provisions for the work. Ensure timely placement of sleeves, inserts and the like.

E. Where work is installed in close proximity to or will interfere with other works, assist in working out satisfactory space arrangements. Prepare composite shop drawings to a suitable scale showing how the work is installed in relation to the work of other trades.

F. Ensure the sufficiency of dimensions of the plant areas, doors etc. and the suitability of slabs and other structural members for placement, operation and maintenance of equipment.

G. Resolve conflicts in requirements with other trades. Refer to the Engineer, only those which cannot be solved without changes to structure or those which involves major changes to system design.

3.02 INSTALLATION

A. Access Door
   1. Provide access doors in walls and ceilings as required for operation and maintenance of concealed equipment, valves, controls, etc.
   2. Coordinate and prepare a location, size and function schedule for all required access doors. Access doors shall be of ample size, minimum 600mm x 600mm.

3.03 FIELD QUALITY CONTROL

A. Test:
   1. During the manufacture (at Contractor's premises only), installation and after completion of works; the system, sections of the system or its components shall be tested by the Contractor / Specialist Subcontractor in the presence of the Engineer, as directed below or elsewhere. The Contractor shall procure all testing instruments and accessories and bear all costs in connections with the same:
      a. Basic materials for conformity with the specified standards.
      b. Supports and anchors for ability to withstand required load.
      c. Wall mounted sanitary fixtures with a dead weight of 100 kgs.
      d. Filtration equipment for flow, head lose, filtration fineness, controls and alarms, regeneration etc.
      e. Control system for operating ranges, tolerances, cutout, alarms etc.
      f. Water supply systems for required flow and pressure at outlets, simulated peak flow conditions (open sectional control valves with estimated no. of outlets in open condition, in series).
      g. Drainage systems for simulated peak flow conditions and performance of trip seals (by simultaneous discharge of all water closets on the stack or groups).
      h. Piping in general for line, level and slopes.
      i. Sanitary fixtures for operation of fittings and proper fixation.

3.04 UTILITY CONNECTIONS

A. Coordinate with the relevant Client Authorities, obtain all necessary information on available utility mains, obtain approvals and permits and pay all fees and expenses in this respect.

B. Prepare coordinated working drawings and applications forms with all required information, submit to the relevant authorities and obtain their approval.

C. Arrange all materials, prepare site and execute / facilitate the execution of the connection, manholes etc. as directed by the relevant authorities.

D. Execute all manholes and road gullies within and outside the site boundary (on the utility line or otherwise) to local standards, in all respects.

E. Execute drop connections to sewerage manholes and provide benching at the bottoms as per regulation and latest detail drawing.

F. Execute drop connections to storm water manholes, when the drop exceeds 50 cm. Provide benching at the bottom, where required.

3.05 ADJUSTING

A. Balance and regulate the following items, systems
   1. Balancing valves in circulating systems for equal or proportionate flow.
   2. Thermostats for cut in cut out temperatures or range.
   3. Angle valves on fixtures supply for regulated flow.

B. Demonstrations
   1. Provide the services of a competent engineer to supervise the commissioning of all equipment and to train the Employer's personnel in all aspects of the same during a ten (10) working days period, during normal working hours. Allow for all costs in connection with the above.
   2. This shall only be done after substantial completion of the Project. Give a minimum of one week written notice and obtain Employer's written consent prior to such demonstrations.

SECTION 220513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION 220513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

Part 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes general requirements for single-phase and three phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 415 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALIFICATION

A. Motors are normally supplied as a part of the mechanical equipment assembly. Manufacturers of such motors shall be as selected/recommended by the equipment manufacturer.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable electrical code.

B. Store and protect products.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. (For extended outdoor storage, remove motors from equipment and store separately).

1.07 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A. Motors:
   1. Siemens
   2. Allen Bradley
   3. AEG
   4. Brook Croption
   5. US Motors.
   6. PEL
   Or approved equal

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors: Design for continuous operation in 55 degrees C environment, and for temperature rise in accordance with limits for insulation class, Service Factor, and motor enclosure type.

B. Visible Nameplate: Indicating motor horsepower, Voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model conduit connection in end frame.

C. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

D. Components such as fuses, contactor, indicator, timers etc. which may require replacement in future shall be product of the same standard or manufacturer as that of the electrical works for this project.

2.03 MOTORS

A. All motors (unless otherwise stated in particular clause/schedule) shall be of Totally Enclosed Fan Cooled (TEFC) type, cooled ventilation and liable to operate continuously and should comply to BS 2613.

B. All motors shall be squirrel cage induction type, with TEFC enclosures unless otherwise stated or dictated by Selection.

C. Provide anti-condensation heaters in stator windings for fire pumps and sump pump motors which are subjected to prolonged disuse.

D. The bearings of the motors shall be of a type requiring just one lubrication per year.

E. The ends of the windings shall reach a terminal box and arrangement shall be such as to allow for an easy permutation of the two phases leads without upsetting the compound when this is done at the ends of the cable.

F. Terminal boxes shall be fixed with a junction box, a cable inlet and an adaptor-plate such as required with necessary adjustments (cable pincers, etc) to suit the specified cable type.

G. Motors shall be supplied with foundations, bolts and sliding rails if necessary.

H. Rotation and colour of the phases shall comply with B.S. 158.

I. All motors shall have windings with class 'B' temperature rise and class 'F' insulation (unless otherwise stated in a particular clause/schedule).

J. Winding bridges, where used shall be tinned copper of adequate size and supplied by the manufacturer.

K. Motor name plates of etched aluminum shall state:
   1. Name of Manufacturer
   2. Serial Number and Frame Size
   3. Power, speed and power factor
   4. Electrical supply
   5. Type of starting.

   The name plate shall be attached to the body by riveting.

2.04 POWER FOR MOTORS

A. All motors shall be wound for the voltage sources indicated.

B. Motors and generators shall comply with BS-2613. Compliance of motors with typical tests by the manufacturer shall not free the Tenderer from his obligations to supply machines capable of operating their respective equipment under normal conditions of load.

C. Ambient temperature for motors and associated equipment installed in the buildings shall be 50 deg. C. for motors installed in the heating room and Diesel room ambient temperature will be 55 deg. C.

D. De-rating of motors shall be based on the above temperatures and climate conditions.

E. All motors shall have a power factor of 0.85 at 75% of its full load.

F. Automatic compensation system for the reactive power for all air conditioning motors is not required and the power factor of these motors will be 0.8 min.

G. Variations in voltage shall not exceed 6% (+ or -) of rated voltage.

H. Variations in frequency shall not exceed 4% (+ or -) of rated frequency.

I. Motors shall be designed to work for a period of at least five minutes at a voltage 25% under rated value and at a rated frequency without abnormal overheating.

2.05 START-UP OF MOTORS

A. All starters shall be of a manufacture meeting B.S.587 and insulated with materials of Class B.

B. Each motor shall be supplied with the required and appropriate starter subject to specific indication to the contrary.

C. Motor starters shall be protected from dust and vermin in a cast iron or steel sheet cabinet designed to be fixed to a wall, a floor or a panel according to requirements.

D. Starters shall be supplied with their push-buttons and a triple pole isolator interlocked with the opening of the cabinet.

E. All contacts of starters exposed to the air shall be strong and of silver or platinum, equipment shall be designed for working of 40 operations per hour.

F. Should the control equipment and the accessory appliances be supplied by a source other than the source of the motor circuit, insulation shall include and accessory contact so that should the motor be insulated, any source accessory to control equipment and to the motor shall also be insulated for all poles.

G. All push-buttons shall be of non-hygroscopic material and shall not swell.

H. Contacts of all switches and push-buttons shall be strong and have self-cleaning action when working.

I. All starters shall have a capacity of 40 operations per hours and shall be of an automatic contactor type unless specified otherwise.

J. All starters shall be supplied with auxiliary contacts so as to have an "ON" "OFF" indication at a distance.

K. Starters shall be supplied with cable glands.

2.06 TYPE OF START-UP

A. Starters for motors of up to 15 HP shall be of a "direct on line" type, and starting current in rated voltage shall not be greater than six times current under full load.

B. Should, for any reason, the above starting-up methods require too much starting-up time for a given motor, the Tenderer may submit other starting-up methods for approval.

2.07 PROTECTION OF MOTORS

A. General
   1. All solenoid shall be of the shaded pole pattern and of such construction that lamination noise is eliminated.

2. All relays shall be housed in cages easily accessible, built-in, dustproof and fixed onto the switch gear cell at eye level and shall be of an automatic return type and complying with B.S.142.
3. All tripping relays shall be supplied with indicators working mechanically so that the cause of the tripping shall be identified immediately. Design shall prohibit the indicator from falling before the relay has accomplished its full travel.
4. All thermal overload relays shall be automatically compensated for variations in ambient temperature.
5. All contacts shall be of silver, platinum or other approved substance.
6. Tripping circuits shall be capable of repeated operations without deteriorating and shall not be influenced by vibrations or external magnetic fields.

2.08 PROTECTION REQUIRED

A. On load pattern switch with H.R.C. cartridge fuses.

B. Under voltage release.

C. Protection from thermal over current and operation in single phase.

D. Protection from early leakage.

E. Open phase protection.

F. Over-current protection.

G. Short circuit protection.

Part 3 - EXECUTION

3.01 Electric motors shall be installed as per manufacturer's recommendations.

3.02 Performance of electric motors shall be as per regulations.

SECTION 220519
METERS AND GAGES FOR PLUMBING PIPING

SECTION 220519
METERS AND GAGES FOR PLUMBING PIPING

Part 1 - GENERAL

1.01 WORK INCLUDED

A. Thermometers and Fittings

B. Pressure Gauges and Fittings

1.02 RELATED SECTION

1. Division 21 – Section “Fire Protection specialties”.
2. Division 22 – Section “Plumbing Piping”.
3. Division 22 – Section “Domestic Water Pumps”.

1.03 REFERENCE STANDARDS

A. BS 1780 - Specification for Borden tube pressure and vacuum gauges.

1.04 QUALITY ASSURANCE

A. Products used in the works covered by this Section shall be provided from specialized manufacturer whose products have been in satisfactory use in similar service for minimum period of five (5) years.

1.05 SUBMITTALS

A. Product data, samples, shop drawings and manufacturer's installation instructions shall be submitted under provisions of the General Conditions of Contract.

1.06 DELIVERY, STORAGE AND HANDLING

A. Products shall be delivered to site, stored and protected under provisions of the Conditions of Contract.

B. Products shall General

C. be kept in shipping cartons until the time of installation.

D. Factory calibrated items which are dropped or subjected to shock otherwise, shall be kept in separate containers with appropriate labels till completion of works. A record of the same shall be kept for inspection by the Engineer.

Part 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Thermometers and Pressure Gauges
   1. Weiss Instruments Inc., USA
   2. WIKA, USA
   3. Dwyer Instruments, USA
   4. WATTS
   5. Ashcroft Inc.
   6. Honeywell.
   7. Terice, USA
   8. LMI, S.A
   9. Uni-Safe, USA
   Or approved equal

2.02 GLASS THERMOMETERS

A. Construction: Baked enamel finished, die-cast aluminium case; Mercury in glass capillary, V-shaped painted aluminum dial and spring secured glass front.

B. Connection: Straight form or 90 ° back angle form as required.

C. Stem: Brass or copper plated steel for separable socket, length to suit installation.

D. Scale: Permanently etched black lines and numerals on white non- reflective back ground, 230 mm (9 inches) long.

E. Calibration: Dual (°C and °F) with 10 °C (20 °F) maximum figure intervals and 1°C (2 °F)smallest graduations.

F. Accuracy: ± One scale division.

G. Range:
   1. Hot water: 0 to 114 °C (30 to 240 °F)
   Ref. : As manufactured Weiss Model # A 9 VU series

2.03 DIRECT READING DIAL THERMOMETERS

A. Construction: Gas filled type with phenol turret case; stainless steel movement; painted aluminum dial and spring secured shatter proof glass front.

B. Connection: Bottom or back as required.

C. Bulb: Rigid stainless steel with union, for separable socket; length to suit installation.

D. Scale: Permanently etched black lines and numerals on white non reflective background, 90 mm (3½ inch) diameter.

E. Calibration: Dual (°C and °F) with 10 °C (20 °F) maximum figure intervals and 1°C (2 °F) smallest graduation.

F. Accuracy: ± One scale division.

G. Range:
   1. Chilled water: - 6 to 82°C (20 to 180 °F)
   2. Hot water: 0 to 114°C (30 to 240 °F)

2.04 PRESSURE AND COMPOUND GAUGES

A. Construction: Phenol turret case; phosphor bronze Borden tube; stainless steel movement; painted aluminum dial and spring secured shatter proof glass front.

B. Connection: 15 mm (½ inch) nom. size, bottom or back as required.

C. Scale: Permanently etched black lines and numerals or white non- reflective background, 90 mm (3½ inch) diameter.

D. Calibration: Dual on the pressure side (Bars and psi) as well as vacuum side (mm and inches of mercury). Figure intervals shall be at 1 Bar (10 psi)) and smallest graduation shall not be more than 0.1 Bar (1 psi).

E. Accuracy: ± One (1) percent.

F. Range:
   1. At suction side of pumps: 760 mm - 0 - 4 Bars (30 inches - 0 - 60 psi)
   2. At discharge side of pumps: 200 percent of pump shut off head, but limited to 20 Bars (300 psi)

2.05 DIFFERENTIAL PRESSURE GAUGES FOR WATER

A. Construction: Phosphor Bronze bourdon tube type with stainless steel case with separation between dial chamber and fluid; painted aluminum dial; clear heavy glass facia; rubber pointer stops; over pressure restrictors; external, pointer zero adjustment etc.

B. Connections: 15 mm (½ inch), high and low pressure taps, at bottom (duplicated at top for air, gas)

C. Scale: Permanently etched / printed black lines and numerals on white non-reflective background, 114 mm diameter (minimum).

D. Calibration: Dual (Bars, feet of water), with figure intervals at 1 Bar (10 feet) and smallest graduation not exceeding 0.1 Bars (1.0 foot).

E. Accuracy: ± Three (3) % of full scale.

F. Range:
   1. 1.5 times of the working pressure but limited to 20 Bars (300 psi).

G. Accessories:

1. Copper capillary tubing with compression fittings
2. Isolating cocks (2 nos.)
3. Bleed fittings (2 nos.)
4. Surface mounting bracket

2.06 PRESSURE GAUGE ACCESSORIES

A. Cocks: bronze bar stock needle valves with female threaded ends.

B. Snubbers: Filter type, of brass / stainless steel construction with porous metal disc.

C. Siphon tubes: Straight coil constructed of schedule 40 steel; size and length as required.

2.07 WARRANTY

A. General Conditions of Contract to be referred to and complied with in respect of warranty requirements.

Part 3 - EXECUTION

3.01 SELECTION AND INSTALLATION OF THERMOMETERS

A. Dial type thermometers shall be installed at the following locations.
   1. As shown on drawings.

B. Thermometers shall be installed with the dial in vertical, upright position and titled to give maximum readability.

3.02 SELECTION & INSTALLATION OF PRESSURE AND COMPOUND GAUGES

A. General: Pressure gauges shall be installed in piping tee, with gauge cock, at the most readable position. Gauges shall be selected with bottom side or rear inlet as appropriate.

B. Compound gauges shall be installed at the following locations:
   1. At the suction manifolds of packaged pump sets, end suction pumps & fire pumps.
   2. At the suction / suction header of unit pumps
   3. At the critical places subject to pressure variations and to the places as per engineers instructions.

C. Pressure gauges shall be installed at the following locations:
   1. At the discharge manifolds of packaged pump sets
   2. At the discharge of unit pumps
   3. At the inlet and outlet of water main (fresh, brackish & treated) incomers from ministries.
   4. At the inlet and outlet of each water heater.
   5. At the inlet and outlet of pressure reducing valve stations.
   6. At the critical places subject to pressure variations and to the places as per engineers instructions.

D. Pressure gauge cocks shall be installed on piping at the following locations. Outlet of these shall be plugged. The client shall be furnished with two (2) nos. pressure gauges of each type and range.
   1. At the inlet and outlet of central station discharge piping.
   2. At the inlet and outlet of hot water circulating pumps and pressure reducing valve stations.
   3. At the interface of water supply system with swimming pools, fountains, automatic irrigation system, etc.
   4. On the city water supply connection, in the vicinity of the break tank.

E. Snubbers shall be installed on all pressure gauges installed in close proximity of pump discharge.

F. Red set hands shall be provided, to indicate normal or critical pressure, in gauges subjected to variable pressures.

G. Remote reading type pressure gauges shall have armoured capillary tubes, when installed above 2 M (7 feet) from FFL.

3.03 SELECTION & INSTALLATION OF DIFFERENTIAL PRESSURE GAUGES

A. General: Differential pressure gauges shall be installed on custom made brackets attached to equipment assembly.

B. Differential pressure gauges (water) shall be installed across central water filters.

C. Gauges with adjustable switches shall be selected for interconnection with Building Management System (BMS), where required.

D. Snubbers shall be provided on all gauges for water.

E. Red set hands shall be provided to indicate normal or critical pressure in gauges subjected to variable pressures.

SECTION 220523
GENERAL DUTY VALVES FOR PLUMBING PIPING

SECTION 220523
GENERAL DUTY VALVES FOR PLUMBING PIPING

Part 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Valve Actuators
   2. Angle Valves
   3. Ball Valves
   4. Butterfly Valves
   5. Check Valves (NRV)
   6. Gate Valves (IV)
   7. Globe Valves
   8. Regulating Valves (RV)

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Non rising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.04 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.05 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use Hand wheels or stems as lifting or rigging points.

1.07 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200)
2. Handwheel: For valves other than quarter-turn types. and larger.
3. Handlever: For quarter-turn valves NPS 6 (DN 150)
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head. and smaller.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch (50-mm)
1. Gate Valves: With rising stem. stem extensions and the following features:
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE ANGLE VALVES

A. Class 150, Bronze Angle Valves with Bronze Disc (Upto diameter 50mm):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following but are not limited to, the following:
   a. Crane Co.
   b. Kitz Corporation.
   c. Nibco Inc.
   d. Milwauke Valve Company
   e. Watts Regulator Co.
   f. Econosto, Netherland
   g. Hattersley, U.K
   Or approved equal

2. Description:
    a. Standard: MSS SP-80, Type 1.
    b. CWP Rating: 230 psig (1590 kPa)
    c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
    d. Ends: Threaded.
    e. Stem and Disc: Bronze.
    f. Packing: Asbestos free.
    g. Handwheel: Malleable iron.

2.03 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim (up to diameter 50mm):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following but are not limited to, the following:
    a. Crane Co.
    b. Kitz Corporation.
    c. Milwaukee Valve Company.
    d. Nibco Inc.
    e. Pegler Hattersly
    f. Watts Regulator Co.
    g. Econosto, Netherland
    h. Hattersley, U.K
    Or approved equal

2. Description:
    a. Standard: MSS SP-110.
    b. SWP Rating: 230 psig (1590 kPa).
    c. CWP Rating: 600 psig (4140 kPa).
    d. Body Design: Two piece.
    e. Body Material: Forged brass.
    f. Ends: Threaded.
    g. Seats: PTFE or TFE.
    h. Stem: Stainless steel.
    i. Ball: Stainless steel, vented.
    j. Port: Full.

2.04 BRONZE LIFT CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Rubber Lined Disc (upto diameter50mm):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
    a. Kitz Corporation.
    b. Milwaukee Valve Company.
    c. NIBCO INC.
    d. Watts.
    e. Pegler - Hattersley.

f. Crane Co.
g. Econosto, Netherland
h. Hattersley, U.K
Or approved equal

2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 230 psig (1590 kPa)
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze, Rubber Lined.

2.05 IRON SWING CHECK VALVES

A. Class 250, Iron Swing Check Valves with Metal Seats and external lever and weight:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following (over diameter 50mm):
a. Crane Co.
b. Kitz Corporation.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.
f. Econosto, Netherland
g. Hattersley, U.K
Or approved equal

2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 300 psig (2070 kPa)
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Seat and Disc: Renewable type.

2.06 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following (over diameter 50mm):
a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.
d. Crane Co.

e. Kitz Corporation.
f. Econosto, Netherland
g. Hattersley, U.K
Or approved equal

2. Description:
a. Standard: MSS SP-125, MIL-V-18436F.
b. CWP Rating: 300 psig (2070 kPa)
c. Body Material: ASTM A 126, gray iron.
d. Style: Flange, globe style, spring loaded.
e. Seat: Bronze alloy or NBR.

2.07 BRONZE GATE VALVES

A. Class 150, RS Bronze Gate Valves (up to diameter 50mm):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
a. Crane Co.
b. Kitz Corporation.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.
f. Pegler - Hattersley.
g. Econosto, Netherland
h. Hattersley, U.K
Or approved equal

2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 230 psig (1590 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.08 IRON GATE VALVES

A. Class 250, OS&Y, Iron Gate Valves (over diameter 50mm):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.
d. Pegler - Hattersley.
e. Crane Co.
f. Econosto, Netherland
g. Hattersley, U.K
Or approved equal

2. Description:
    a. Standard: MSS SP-70, Type I.
    b. CWP Rating: 230 psig (1590 kPa).
    c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    d. Ends: Flanged.
    e. Trim: Stainless steel 316.
    f. Disc: Solid wedge.
    g. Packing and Gasket: Asbestos free.
    h. Seat and Disc: Renewable type.

2.09 BRONZE GLOBE VALVES

A. Class 150, Bronze Globe Valves with Nonmetallic Disc (up to diameter 50mm):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
    a. Crane Co.
    b. Kitz Corporation.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    f. Pegler.
    g. Econosto, Netherland
    h. Hattersley, U.K
    Or approved equal

2. Description:
    a. Standard: MSS SP-80, Type 2.
    b. CWP Rating: 230 psig (1590 kPa).
    c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
    d. Ends: Threaded.
    e. Stem: Bronze.
    f. Disc: PTFE or TFE.
    g. Packing: Asbestos free.
    h. Handwheel: Malleable iron.

2.10 IRON GLOBE VALVES

A. Class 250, Iron Globe Valves (over diameter 50mm):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
    a. Crane Co.
    b. Milwaukee Valve Company.
    c. NIBCO INC.
    d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    e. Pegler .
    f. Econosto, Netherland
    g. Hattersley, U.K
    Or approved equal

2. Description:
    a. Standard: MSS SP-85, Type I.
    b. CWP Rating: 230 psig (1590 kPa).
    c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    d. Ends: Flanged.
    e. Trim: Bronze.
    f. Packing and Gasket: Asbestos free.

2.11 REGULATING VALVE/DOUBLE REGULATING VALVE

A. Class 150, Bronze double regulating valve (up to diameter 50mm).

1. Manufacturers:
    a. Crane Co.
    b. Hattersley
    c. Singer
    d. TACO
    e. Bell
    f. Econosto, Netherland
    g. Hattersley, U.K
    Or approved equal

2. Description:
    a. Standard: BS 7350 & BS 5154 Series B
    b. CWP Rating: 230 psig (1590 kpa)
    c. Body Material: Bronze
    d. Bonnet: DZR & non-asbestos gasket
    e. Disk: DZR with PTFE insert
    f. Type: Y pattern with DZR throttling disk
    g. Ends: Threaded
    h. Setting: Up to 40 through 4 hand wheel resolution
    i. Accuracy: ± 5% when fully open

2.12 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, but are not limited to, the following:
    1. Babbitt Steam Specialty Co.
    2. Roto Hammer Industries.
    3. Trumbull Industries.
    4. Or approved equal

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
    1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
    2. Attachment: For connection to butterfly valve stems.
    3. Sprocket Rim with Chain Guides: Ductile or cast iron of type and size required for valve. Include zinc coating.
    4. Chain: Hot-dip, galvanized steel of size required to fit sprocket rim.

Part 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Locate valves for easy access and provide separate support where necessary.

B. Install valves in horizontal piping with stem at or above center of pipe.

C. Install valves in position to allow full stem movement.

D. Install chainwheels on operators for butterfly/gate/globe and plug valves [NPS 6 (DN 150)] <Insert size> and larger and more than 96 inches (2400 mm) above floor. Extend chains to60 inches (1520 mm) above finished floor.

E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly or gate valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service: Globe valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze rubber lined disc.
      b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient seat check valves.
      c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50)
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below. and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
   7. For Grooved-End Steel Piping: Valve ends may be grooved.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50)
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends. and Smaller:
   2. Bronze Angle Valves: Class 150 disc.
   3. Ball Valves: Two piece full port bronze with stainless-steel trim.
   4. Bronze Swing Check Valves: Class 150 bronze disc.
   5. Bronze Gate Valves: Class 150 RS.
   6. Bronze Globe Valves: Class 150 bronze disc.

B. Pipe NPS 2-1/2 (DN 65)
   1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends. and Larger:
   2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM/NBR seat, stainless-steel disc.
   3. Iron, Grooved-End Butterfly Valves: 300 CWP.
   4. Iron Swing Check Valves: Class 250 nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
6. Iron, Grooved-End Swing Check Valves: 300 CWP.
7. Iron, Center-Guided Check Valves: Class 250 compact-wafer/globe, resilient seat.
8. Iron, Plate-Type Check Valves: Class 250 dual plate; resilient seat.
9. Iron Gate Valves: Class 250 OS&Y.
10. Iron Globe Valves: Class 250.

3.06 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65)
1. Iron Valves, and Larger: NPS 2-1/2 to NPS 4 (DN 65 to DN 100)
2. Iron Swing Check Valves: Class 250 metal seats. : May be provided with threaded ends instead of flanged ends.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring/weight.
4. Iron, Grooved-End Swing Check Valves: 300 CWP.
5. Iron Gate Valves: Class 125 NRS.
6. Iron Globe Valves: Class 125.

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Supports, anchors and seals complete in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   1. Horizontal-Piping Hangers and Supports.
   2. Vertical-Piping Clamps.
   3. Hanger-Rod Attachments.
   4. Building Attachments.
   5. Saddles and Shields.
   6. Spring Hangers and Supports.
   7. Miscellaneous Materials.
   8. Anchors.
   9. Equipment Bases.

1.02 REFERENCES

A. Manufacturer Standardization Society of the valve and fitting industry:
   1. MSS SP-58 : Pipe Hangers and Supports Materials, Design and Manufacturer.
   2. MSS SP-69 : Pipe Hangers and Support – Selection and Application.
   3. MSS SP-77 : Guidelines for Pipe Support Contractual Relationship.
   4. MSS SP-89 : Pipe Hangers and Support – Fabrication and Installation Practices.

B. Under Writers Laboratories (UL)
   1. Applicable Publications.

1.03 SUBMITTALS

A. Product Data: Submit catalogue cuts, specification, installation instructions and dimensioned drawings for each type of support, anchor and seal. Submit pipe hanger and support schedule showing manufacturers figure number, size, location and features for each required pipe hanger and support.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualification: Firms regularly engaged in manufacture of supports and anchors, of type and size required whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Regulatory Requirements:
   1. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A. Saddles and Shields, Hayers & Supports
   1. B-Line System Inc.
   2. ITT Grinnel Corp., U.S.A.
   3. ANVIL
   4. TOLCO-NIBCO, U.S.A.
   5. HILTI
   6. FLAMCO
   7. Unistrut
      Or approved equal

B. The products or manufacturers listed here in are included for the purpose of establishing minimum quality standards.

2.02 MATERIALS

A. Horizontal – Piping Hangers and Supports
   1. General: Except as otherwise indicated, provide hot dipped galvanized factory fabricated horizontal-piping hangers and supports complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by the Contractor and approved by the Engineer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper piping systems. Use FM/UL type of Hangers for Fire Protection piping application.

B. Adjustable Steel Band Hanger: MSS type -10 for suspension of metallic non insulated or insulated stationary pipelines; 13mm to 50mm (½" to 2").

C. Adjustable Steel Clevises: MSS Type 1. For suspension of metallic non insulated or insulated stationary pipelines; 65mm to 250mm (2½" to 10").

D. Alloy Steel Pipe Clamps: MSS Type 2. For suspension of metallic high temperature pipe requiring up to 100mm (4") of insulation; 100mm to 400mm (4" to 16").

E. Steel Double Bolt Pipe Clamps: MSS Type 3. For suspension of metallic pipe requiring up to 100mm (4") of insulation and where flexibility of clamp is desirable; 19mm to 600mm (3/4" to 24").

F. Steel Pipe Clamps: MSS Type 4. For suspension of metallic cold pipe lines or hot pipe lines where little or no insulation is required; 13mm to 600mm (½" to 24").

G. Pipe Hangers: MSS Type 5. For suspension of metallic piping when off-center closure allowing installation of hanger before erection of piping is desired; 13mm to 100mm (½" to 4").

H. Adjustable Swivel Rings, Band Type: MSS Type 10. For suspension of metallic non insulated stationary pipe lines; 13mm to 50mm (½" to 2").

I. Split Pipe Rings: MSS Type 11. For suspension of metallic non- insulated stationary pipe lines; 10mm to 200mm (3/8" to 8").

J. Extension Split Pipe Clamps: MSS Type 12. For suspension of metallic non-insulated stationary pipe lines; 10mm to 75mm (3/8" to 3").

K. U-Bolt: MSS Type 24. For support of heavy loads; 13mm to 750mm (½" to 30").

L. Clips: MSS Type 26. For support of uninsulated piping not subject to expansion or contraction.

M. Pipe Slides and Slide Plates: MSS Type 35. For support of piping where horizontal movement resulting from expansion and contraction takes place and where low coefficient of friction is desired. Include one of the following plate types:
   1. Plate: Unguided type.
   2. Plate: Guided type.
   3. Plate: Hold-down clamp type.

N. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast-iron floor flange. To support pipe from floor stanchion, using floor flange to secure stanchion to floor; 100mm to 1200mm (4" to 36").

O. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange. Equivalent to Type 36 except U-bolt provided for retaining pipe

P. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange. For stanchion type support where vertical adjustment is required; 63mm to 1200mm (2½" to 36").

Q. Adjustable Roller Hangers: MSS Type 43. For suspension of pipe from a single rod where horizontal movement may occur because of expansion or contraction; 150mm to 500mm (6" to 20").

R. Clips: For support of plastic pipes where longitudinal movement resulting from expansion and contraction may take place; proved heavy duty galvanized pipe ring in two halves swaged for good strength having screw clamping with acoustic insulated pre-fitted rubber inlay non-shifting type and solid, welded on nuts for clamping anchor rods M8 to M12 as required for pipe sizes; 15mm to 200mm.

2.03 VERTICAL-PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory- fabricated vertical-piping clamps complying with ANSI/MSSSP-58, of one of the following types listed,

selected by the Contractor and approved by the Engineer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems.

B. Two-Bolt Riser Clamps: MSS Type 8. For support and steadying of pipe risers; 19mm to500mm (3/4" to 20"). Also supports pipe covering or insulation.

C. Four-Bolt Riser Clamps: MSS Type 42. When longer ends are required for riser clamps.

D. Clips: For support of plastic pipes provide pipe ring in two halves clamping with screw and pre-fitted rubber inlay and solid welded on nuts for clamping anchor rods for pipes 15mm to 200mm.

2.04 HANGER-ROD ATTACHMENTS

A. General: Except as otherwise indicated provide factory- fabricated hanger-rod attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by the Contractor and approved by the Engineer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

B. Steel Turnbuckles: MSS Type 13. To provide adjustment up to 150mm (6") for heavy loads.

C. Steel Clevises: MSS Type 14. For use on high temperature piping installations.

D. Swivel Turn buckles: MSS Type 15. To be used with split pipe rings, MSS Type 11.

E. Malleable Iron Sockets: MSS Type 16. For attaching hanger rod to various types of building attachments.

F. Steel Weld less Eye Nuts: MSS Type 17. For use on high temperature piping installations.

2.05 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory fabricated building attachments complying with ANSI/MSS SP-58, of one of the following MSS types listed, selected by the Contractor and approved by the Engineer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems.

B. Concrete Inserts: MSS Type 18. For upper attachment for suspending pipe hangers from a concrete ceiling.

C. Top Beam C-Clamps: MSS Type 19. To be used under roof installations with bar joist construction, for attachment to top flange of structural shape.

D. Side Beam or Channel Clamps: MSS Type 20. For attachment to bottom flange of beams, channels, or angles.

E. Center Beam Clamps: MSS Type 21. For attachment to center of bottom flange of beams.

F. Welded Attachments: MSS Type 22. For attachment to bottom of beams where loads are considerable and rod sizes are large.

G. C-Clamps: MSS Type 23. For attachment to structural shapes.

H. Top I-Beam Clamps: MSS Type 25. For attachment to top of beams when hanger rod is required tangent to edge of flange.

I. Side I-Beam Clamps: MSS Type 27. For attachment to bottom of steel I-beams.

J. Steel I-Beam Clamps with eye Nut: MSS Type 28. For attachment to bottom of steel I beams for heavy loads.

K. Steel WF-Beam Clamps with eye Nut: MSS Type 29. As Type 28 with link extensions.

L. Malleable Beam Clamps: MSS Type 30. For attachment to structural steel.

M. Steel Brackets: One of the following for indicated loading. To be used for support from below, or by using clip and rod for suspending from above. Light duty: 340 Kg. (750 lbs.), Medium: 680 Kg. (1500 lbs.), Heavy: 1360 Kg. (3000 lbs.).
   1. Light Duty: MSS Type 31.
   2. Medium Duty: MSS Type 32.
   3. Heavy Duty: MSS Type 33.

N. Side Beam Brackets: MSS Type 34. For use on sides of steel or wooden beams.

O. Plate Lugs: MSS Type 57. For attachment to steel beams where flexibility at the beam is desired.

P. Horizontal Travelers: MSS Type 58. For supporting piping systems subject to linear horizontal movements where head room is limited.

2.06 SADDLES AND SHIELDS

A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory- fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.

D. Thermal Hanger Shields: Constructed of 360‘ insert of high density, 690 KPa (100 psi),waterproofed calcium silicate, encased in 360‘ sheet metal shield. Provide assembly of same thickness as adjoining insulation.

2.07 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of one (1) part cement to three (3) parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

E. Pipe Guides: Provide factory-fabricated guides, of cast semi steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

Part 3 - EXECUTION

3.01 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

B. Prior to installation of hangers, supports, anchors and associated work, the Contractor shall meet at project site with inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this Section, and the Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.02 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in Drawing MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping. Provide concrete inserts, where required to be installed before structural concrete is placed.

3.03 INSTALLATION OF HANGERS AND SUPPORTS

A. General
   1. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.

   2. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
   3. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized approved methods.

B. Provisions for Movement
   1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units. Contractor to check and confirm that loads from equipment, piping etc can be safely accommodated by structure.
   2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
   3. Pipe Slopes: Install hangers and supports to provide required pipe slopes and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

C. Insulated Piping
   1. Comply with the following installation requirements.
      a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSIB31.
      b. Shields: Where low-compressive-strength insulation or vapour barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 200mm (8”) and over, install wood insulation saddles.
      c. Saddles: Where insulation without vapour barrier is indicated, install protection saddles.

3.04 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer’s written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor Spacings: where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.05 ADJUSTMENT OF HANGERS AND SUPPORTS

A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.06 EQUIPMENT BASES

A. Construct suitable concrete bases for the elevated support of all floor mounted equipment. Furnish, for the Engineer's approval, scaled layouts of all required bases, with dimensions and location to column center lines, and templates, anchors bolts and accessories, necessary for base construction.

B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of approved structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

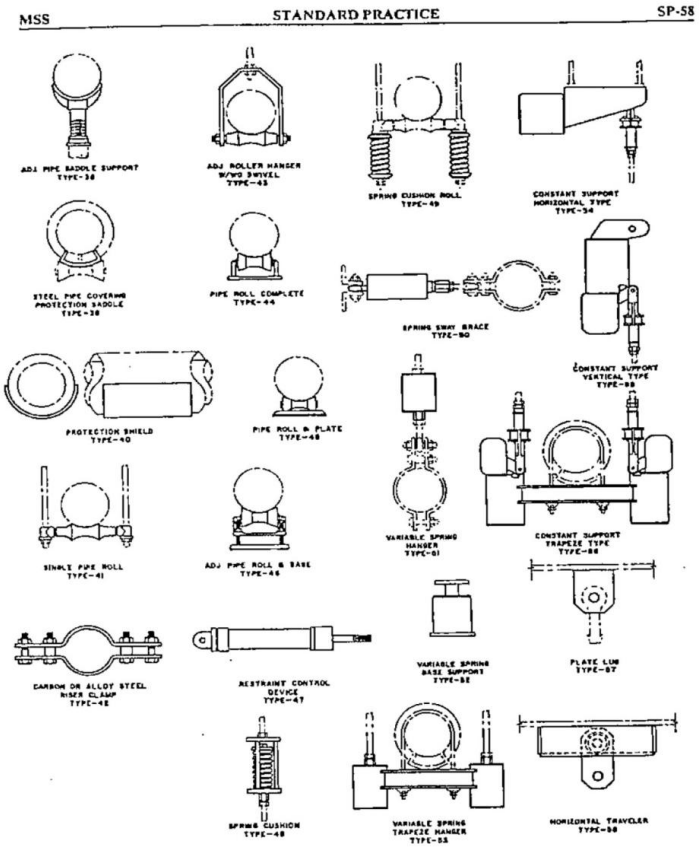


FIGURE 1. TYPE CHART (Continued)

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Mechanical identification devices complete in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
      a. Painted Identification Materials.
      b. Plastic Pipe Markers.
      c. Plastic Tape.
      d. Valve Tags.
      e. Valve Schedule Frames.
      f. Engraved Plastic-Laminate Signs.
      g. Plasticized Tags.

1.02 REFERENCES

A. American National Standards Institute:
   1. ANSI 13.1 “Letting Colours and Viewing Angles of Identification Devices”.

B. Occupational Safety and Health Administration (OSHA)
   1. Relevant parts of the publication.

1.03 SUBMITTALS

A. Product Data: Submit to Engineer for information only, product specifications and installation instructions for each identification material and device required.

B. Samples: Submit samples of each colour, lettering style and other graphic representation required for each identification material or system.

C. Schedule: Submit valve schedule for each piping system, typewritten and reproduced on A4 size paper bound. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any).Mark valves which are intended for emergency shut-off and similar special uses, by special “flags”, in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacturer of identification devices of type and size required, whose products have been in satisfactory use in similar service for not less than five (5) years.

1.05 MAINTENANCE

A. SPARE PARTS
1. Deliver spare parts to Employer stores.
2. Obtain Engineers approval for the delivered spare parts.

Part 2 - PRODUCTS

2.01 MANUFACTURER

A. Mechanical Identification
   1. Apple baum Tag & Lable (U.S.A.)
   2. Brady (WH) Co., Sign mark Div.,
   3. Seton Name Plate Corp. (U.S.A.)
      Or approved equal

B. The products or manufacturers listed herein are included for the purpose of establishing minimum quality standards.

2.02 MATERIALS

A. Mechanical Identification Materials
   1. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Sections. Where more than single type is specified for application, selection is Contractor's option, and as approved by the Engineer, but provide single selection for each product category.

B. Painted Identification Materials
   1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI/ASME A31.1 for piping and similar applications, but not less than 32mm (1-1/4") high letters for ductwork, and not less than 19mm (3/4") high letters for access door signs and similar operational instructions.
   2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

   3. Identification Paint: Standard identification enamel of colours indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colours.

C. Plastic Pipe Markers:
   1. General: Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, colour coded, plastic-sheet pipe markers, complying with ANSI A13.1 and as follows:
      a. Small Pipes: For external diameters less than 150mm (6") (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
         i) Snap on application of pre-tensioned semi-rigid plastic pipe marker.
         ii) Adhesive lap joint in pipe marker overlap.
         iii) Laminated or bonded application of pipe marker to pipe (or insulation).

iv) Taped to pipe (or insulation) with colour-coded plastic adhesive tape, not less than 19mm (3/4") wide; full circle at both ends of pipe marker, tape lapped 38mm (1-1/2").

b. Large Pipes: For external diameters of 150mm (6") and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than three times letter height (and of required length), fastened by one of the following methods:
   i) Laminated or bonded application of pipe marker to pipe (or insulation).
   ii) Taped to pipe (or insulation) with colour-coded plastic adhesive tape, not less than 38mm (1-1/2") wide; full circle at both ends of pipe marker, tape lapped 75mm (3").
   iii) Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

c. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
   i) Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

D. Plastic Tape:
1. General: Manufacturer's standard colour-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 0.07mm (3 mils) thick.
   a. Width: Provide 38mm (1-1/2") wide tape markers on pipes with outside diameters (including insulation, if any) of less than 150mm (6"); 63mm (2-1/2") wide tape for larger pipes.
   b. Colour: Comply with ANSI A13.1/BS, except where another colour selection is indicated and as approved by the Engineer.

E. Valve Tags:
1. Brass Valve Tags: Provide 19 gauge polished brass valve tags with stamp-engraved piping system abbreviation in 6mm (1/4") high letters and sequenced valve numbers 13mm (1/2") high, and with 4mm (5/32") hole for fastener.
   a. Provide 38mm (1-1/2") diameter tags, except as otherwise indicated.
   b. Fill tag engraving with black enamel.
2. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

F. Valve Schedule Frames: For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

G. Engraved Plastic-Laminate Signs:
1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter colour) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

a. Thickness: 1.6mm (1/16”) for units up to .013 Sq .m (20 Sq. in.) or 200mm (8”) length; 3mm (1/8”) for larger units.
b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2. Plasticized Tags
   a. General: Manufacturer’s standard pre-printed or partially pre-printed accident prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 81mm x 140mm (3-1/4” x 5-5/8”), with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE) in English and Urdu.

2.03 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled and comply with ANSI A.13.1 for lettering size, colours and viewing angles of identification devices. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
   1. Multiple Systems: Where multiple systems of same generic name and specified, provide identification which indicates individual system number as well as service (as examples; Air Supply No. 1H, Standpipe F12).
   2. Provide lettering and wording in both Urdu and English.

2.04 COLORS

A. Requirements of the reference standards shall be conformed to, unless otherwise indicated.

B. Co-ordinated schedule shall be made in agreement with all other similarly identified services, avoiding confusing repetitions.

C. Prevailing governmental regulations shall be complied with, where appropriate, like for gas piping.

D. Following colors shall be construed to mean as colors defined by the BS color numbers (the color names given are adapted from the Dulux range of the ICI Company, UK for reference only).

Sl. No.	Color Names	Abbreviation	BS Colour No.
1.	White	Wt	00 E 55
2.	Portland Grey	PG	00 A 01
3.	Goosewing Grey	WG	00 A 05
4.	Flint Grey	FG	00 A 09
5.	Larkspur Blue	LB	18 E 51
6.	Regatta Blue	RB	18 E 53
7.	Viking Blue	VB	20 C 37
8.	Midnight Blue	MB	20 C 40

9.	Trafalgar Blue	TB	20 D 45
10.	Cornflower Blue	CB	20 E 51
11.	Orchard Green	OG	12 C 39
13.	Leaf Green	LG	12 D 43
14.	Citrine Green	CG	12 E 51
15.	Linden Green	NG	12 E 53
16.	Garland Green	GG	14 E 51
17.	Verona Green	VG	14 E 53
18.	Willow Green	WG	12 B 17
19.	Aztec Yellow	AY	10 E 53
20.	Goldcup Yellow	GY	08 E 51
21.	Cameo Cream	CC	06 C 33
22.	Cinnamon Cream	IC	06 C 37
23.	Nectar Cream	NC	06 E 56
24.	Shell Pink	SP	04 C 33
25.	Orange	Or	06 E 51
26.	Azalia Red	AR	04 E 51
27.	Poppy Red	PR	04 E 53
28.	Monarch Red	MR	04 D 45
29.	Black	Bk	00 E 53

2.05 PIPE MARKERS

A. 150 mm (6 inch) wide band of colors (as scheduled below); using two ply, self adhesive vinyl tapes with 12 mm (½ inch) overlap; shall be applied around the pipes.

B. External Utilities

1. Client Fresh Water	Wt / LG / Wt
2. Client Brackish Water	Wt / TB / Wt
3. Fresh Water Distribution	Wt / GG / Wt
4. Brackish Water Distribution	Wt / CB / Wt
5. Fire Protection Water Supply	Wt / PR / Wt

C. Landscape Irrigation System

1. Pressure Lines to Spray Zones	Wt / CB / Wt
2. Pressure Lines to Drip Zones	CB / Wt / CB

D. Fire Protection System

1. Fire Protection Water Supply	Wt / PR / Wt
2. Hose Reel System	Wt / AR / Wt
3. Wet Standpipe System	Wt / PR / Wt
4. Sprinkler System	Wt / MR / Wt

E. Plumbing Services

1. Filtered Fresh Water	Wt / VG / Wt
2. Fresh Water Supply	Wt / GG / Wt
3. HVAC Cooling Tower Make-up Supply	Wt / FG / Wt
4. HVAC Chilled Water Make-up Supply	FG / Wt / Wt
5. Cold Water Supply	Wt / GG / Wt
6. Hot Water Supply	Wt / Or / Wt
7. Hot Water Return	Wt / SP / Wt

8. Soil and Waste Pipes	Wt / Bk / Wt
9. Vent Pipes	Wt / AY / Wt
10. Rain Water Pipes	Wt / CC / Wt
F. Fuel Gas Supply	
1. Liquified Petroleum Gas	GY / WG / GY
2. Fuel Gas Supply	GY / Wt / GY
3. Natural Gas	GY / WN / GY

2.06 DIRECTIONAL ARROWS

A. Two-ply, self adhesive vinyl strip markers of size 50 x 150 mm (minimum) with white arrows on background of respective colors shall be provided to indicate direction of flow in pipes.

Part 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements
1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Ductwork Identification
1. General: Identify air supply, return, exhaust, smoke, ventilation, intake and relief ductwork with stenciled signs and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork paint colour).

2. Location: In each space where ductwork is exposed, or concealed locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 15m (50') spacings along exposed runs.
3. Access Doors: Provide stenciled or plastic-laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

C. Piping System Identification
1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
    a. Stenciled markers, including colour-coded background band or rectangle, and contrasting lettering of black or white. Extend colour band or rectangle 50mm (2") beyond ends of lettering.
    b. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non insulated pipes.
2. Locate pipe markers and colour bands for all pipework in all spaces such as machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), exterior and concealed locations.
    a. Near each valve and control device.
    b. Near each branch, excluding short take offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
    c. Near locations where pipes pass through walls or floors/ceilings, or enter non accessible enclosures.
    d. At access doors, manholes and similar access points which permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.

f. Spaced intermediately at maximum spacing of 15m (50') along each piping run, except reduce spacing to 7.5m (25') in congested areas of piping and equipment.
g. On piping above acoustical ceilings.

D. Valve Identification
1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, and shut-off valves at HVAC terminal devices and similar rough-in connections of endues fixtures and units. List each tagged valve in valve schedule for each piping system.
2. Tagging Schedule: Provide tagging schedule to the approval of the Engineer.

3. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by the Engineer.
   a. Where more than one major machine room is shown for the Project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

E. Mechanical Equipment Identification
1. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
   a. Main control and operating valves, including safety devices and hazardous units.
   b. Meters, gages, thermometers and similar units.
   c. Pumps and similar motor driven units.
   d. Coils, evaporators.
   e. Tanks and pressure vessels, air separators and sand filters.
   f. Chemical treatment equipment and piping.
2. Optional Sign Types: Where lettering larger than 25mm (1") height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Contractor's option.
3. Lettering Size: Minimum 6mm (1/4") high lettering for name of unit where viewing distance is less than 600mm (2' -0"), 13mm (1/2") high for distances up to 1800mm (6' -0"), and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to ¾ the size of principal lettering.
4. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicated safety and emergency precautions, and warn of hazards and improper operations.
5. Optional Use of Plasticized Tags: At the Contractor's option, where equipment to be identified is concealed above acoustical ceilings or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

SECTION 220719
PLUMBING PIPING INSULATION

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 – GENERAL

1. 1 SUMMARY

A. Section Includes:
1. Closed-cell elastomeric insulation for domestic hot water PPR piping.
2. Mineral (rock) wool insulation for diesel generator exhaust piping.
3. Insulation adhesives, vapor barriers, protective jacketing, and accessories required for a complete installation.

1. 2 REFERENCES

Comply with the latest editions of the following standards:
- ASTM C534 – Flexible Elastomeric Cellular Thermal Insulation.
- ASTM C547 – Mineral Fiber Pipe Insulation.
- ASTM C795 – Thermal Insulation for Stainless Steel.
- ASTM E84 – Surface Burning Characteristics.
- EN 14304 – Elastomeric Thermal Insulation Products.
- EN 14303 – Mineral Wool Thermal Insulation Products.
- EN 13501-1 – Fire Classification of Construction Products.
- ASHRAE 90.1 – Energy Standard for Buildings.

1. 3 SUBMITTALS

Submit the following:

A. Manufacturer's Product Data.

B. Technical Data Sheets.

C. Shop Drawings indicating insulation thicknesses and installation details.

D. Samples of insulation and protective jacketing upon request.

E. Manufacturer's installation instructions.

F. Warranty certificate.

1. 4 QUALITY ASSURANCE

A. Products shall be manufactured by companies having a minimum of five (5) years' experience in the production of insulation materials.

B. All insulation materials shall be new, factory manufactured, and installed in accordance with the manufacturer's recommendations.

1. 5 DELIVERY, STORAGE AND HANDLING

A. Deliver insulation materials in original unopened packages.

B. Store indoors in a clean, dry location protected from sunlight, moisture, chemicals and physical damage.

1. 6 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

PART 2 – PRODUCTS

2.1 CLOSED-CELL ELASTOMERIC INSULATION (FOR HOT WATER PPR PIPING)

Manufacturers

- Armacell (ArmaFlex)
- K-FLEX
- Aeroflex
- NMC
- Approved equivalent

Material

- Flexible closed-cell elastomeric foam (NBR/PVC or EPDM).
- Factory-made tubular insulation.
- Fiber-free.
- CFC/HCFC free.
- Resistant to mold and moisture.

Physical Properties

- Thermal Conductivity:
  - ≤0.036 W/m·K at 0°C
  - ≤0.040 W/m·K at 40°C
- Density: **45–70 kg/m³**
- Water Vapor Resistance Factor (μ): **≥7000**
- Closed Cell Content: **≥95%**
- Service Temperature: **−50°C to +110°C**
- Fire Classification: **Euro class B-s3, d0** or ASTM E84 Class A.

Minimum Thickness

Pipe Size	Thickness
DN15–DN25	20 mm
DN32–DN50	25 mm
DN65–DN100	32 mm
DN125 and above	40 mm

Accessories

Provide compatible adhesive, sealing tape, fittings, vapor barrier sealant and PVC or aluminum protective jacket where exposed.

2.2 MINERAL (ROCK) WOOL INSULATION (FOR DIESEL GENERATOR EXHAUST PIPING)

Manufacturers

- ROCKWOOL
- Knauf
- Owens Corning
- ISOVER
- Approved equivalent

Material

- High-density preformed rock wool pipe insulation.
- Non-combustible.
- Hydrophobic.
- Suitable for high-temperature exhaust systems.

Physical Properties

- Density: **80–100 kg/m³**
- Thermal Conductivity: **≤0.040 W/m·K**
- Maximum Service Temperature: **650°C minimum**
- Melting Point: **>1000°C**
- Fire Classification: **Euro class A1**

Minimum Thickness

Pipe Size	Thickness
DN40–DN80	50 mm
DN100–DN200	75 mm
DN250 and above	100 mm

Protective Jacketing
Provide **0.80 mm stucco embossed aluminum cladding** complete with stainless steel bands, elbows, end caps, flashings and weatherproof sealing.

PART 3 – EXECUTION

3. 1 EXAMINATION

Verify piping installation has been completed and pressure tested before installing insulation.

3. 2 INSTALLATION

A. Install insulation in accordance with the manufacturer's written instructions.

B. Install insulation continuously over all piping, fittings, valves, flanges and accessories.

C. Seal all longitudinal and circumferential joints with manufacturer's approved adhesive or tape.

D. Install removable insulated covers on valves, flanges and equipment requiring maintenance.

E. Protect outdoor insulation with aluminum cladding or other approved weatherproof finish.

3. 3 FIELD QUALITY CONTROL

A. Inspect insulation for continuity, proper thickness and secure attachment.

B. Repair damaged insulation before project completion.

C. Replace insulation that is wet, damaged or improperly installed.

3. 4 CLEANING AND PROTECTION

A. Remove all installation debris.

B. Clean finished insulation surfaces.

C. Protect completed insulation from damage until final project acceptance.

SECTION 221116
DOMESTIC WATER PIPING

SECTION 221116
DOMESTIC WATER PIPING

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Flexible connectors.
5. Water meters furnished by utility company for installation by Contractor.
6. Water meters.

B. Related Section:
1. Division 22 Section "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions.

1.03 SUBMITTALS

A. Section Includes:
1. Water meters.
2. Backflow preventers, Vacuum breakers Backflow preventers and vacuum breakers.

B. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Fire-suppression-water piping.
2. Domestic water piping.
3. HVAC hydronic piping.

C. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with BS:EN (British European) standards for potable domestic water piping and components.

1.05 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.06 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Approved Manufacturers
   1. Bor-Plus
   2. Polymutan
   3. Kelen
   4. Unidelto – Italy
   5. Wirsbo – Sweden
   6. Uponor - Germany
      Or approved Equal

2.02 PPR PIPING

A. Hot & Cold water Pipes and fittings:

B. PN-25 polypropylene pipes with multilayer with fiber manufactured with compliance to the DIN 8077/8078, and Fittings to the DIN 16962 with a PN-25 pressure class.

C. Pipes and fittings shall be joined by poly- fusion method, using a fusion welding machine as per pipe manufacturer's recommendation, as suitable for their piping system.

D. Threaded fittings shall be used to connect to other piping systems, fixtures, etc., fitting with metal insert shall be sealed with Teflon tape, and all PPR fittings with metal inserts should be made of Brass plated by a nickel layer.

E. PP-R piping system shall be installed with special pre-caution for thermal expansion especially for exposed installation, thermal expansion coefficient of the selected material should not exceed 0.035mm/m.K.

F. All pipes and fitting used to transport the hot water should be insulated as per the DIN1988, thermal conductivity of the selected material should not exceed 0.21W/m.C

G. All PP-R pipes shall not be installed or stored under direct UV light. Pipes on roof shall be insulated and cladded (UV protection)

H. Pipe bending shall be generally avoided, PP-R pipes and fittings shall be certified for potable water use by a recognized European Standard. DVGW or approval equivalent.

I. All system components should be able to resist an emergency operating temperature up to 110C. Pipes and fittings should be produced by the same manufacturer using the same raw material source with the natural color of the polypropylene without any additives or coloring of the pipes and fittings. Contractor to ensure that the velocity of the flow will not exceed the 1.5m/s inside the floors and not to exceed the 2.0m/s in riser pipes. In order to minimize the friction and pressure losses in the network only elbows with Non-centric profiles shall be used.

2.03 PEX TUBE AND FITTINGS (Not Applicable)

A. Cold and hot water distribution pipe work embedded within builder's work inside toilets, bathrooms, kitchen shall be composed of :

B. PN20 Cross linked polyethylene pipe according to DIN 16892 and 16893 and should be NSF approved and should comply with the requirements of the ASTM F876/877 pulled in a corrugated conduit of ordinary polyethylene. Fittings of DZR construction. Proposed pipes should be DVGW & AENOR approved.

C. The Inner Pipe shall be a cross linked polyethylene. Pipe withstanding up to 95 deg. °C at a max. Pressure of 10 bar without deformation or Damage. Short time temperature loading up to 110deg.C

D. Pipes manufacturer shall offer 50 years grantee for the pipes and 10 years for the complete system.

E. All pipes shall be stamped on equal intervals showing clearly the name of the manufacturers along with the pressure and temperature rating of these pipes

F. All pipes shall be laid so that the 16mm PEX water pipe can be replaced if necessary.

G. Fittings& Accessories:
   1. Pipes shall be connected to the different fittings via a wall box of reinforced plastic fitted with bronze elbow suitable for 15mm or 20mm threaded connection. The box should be suitably designed in order to enable the replacement of existing pipes in the event of their damage.
   2. Both pipes and fittings to be produced by the same manufacturer.

2.04 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.”

2.05 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.06 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:
   1. Description:
      a. Pressure Rating: 150 psig.
      b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Description:
      a. Pressure Rating: 150 psig.
      b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Couplings:
   1. Description:
      a. Galvanized-steel coupling.
      b. End Connections: Female threaded.
      c. Lining: Inert and noncorrosive, thermoplastic.

2.07 FLEXIBLE CONNECTORS

A. Manufacturers: Refer to Appendix A

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig
   2. End Connections 50mm and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections 65mm and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections 50mm and Smaller: Threaded steel-pipe nipple.
   3. End Connections 65mm and Larger: Flanged steel nipple.

2.08 WATER METERS.

A. Displacement-Type Water Meters:
   1. Manufacturers:
      a. Hunter
      b. Wiess
      c. Winters
         Or approved Equal

   2. Description:
      a. Standard: AWWA C700.
      b. Pressure Rating: 150 psig working pressure.
      c. Registration: In gallons or cubic meters as required by utility.
      d. Case: Bronze.
      e. End Connections: Threaded.

Part 3 - EXECUTION

3.01 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure reducing valves.

E. Install domestic water piping level with 0.25 percent slope downward toward drain.

F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

G. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install PEX piping with loop at each change of direction of more than 90 degrees.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

S. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
   2. PVC Piping: Join according to ASTM D 2855.

H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping 50mm and smaller. Use butterfly or gate valves for piping 65mm and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
   2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping 50mm and smaller and butterfly valves for piping 65mm and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.05 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. 40mm and Smaller: Fitting-type coupling.
   2. 50mm and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping 50mm and Smaller: Plastic-to metal transition fittings.

3.06 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.07 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

B. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.08 WATER METER INSTALLATION

A. Rough-in domestic water piping for water meter installation according to utility company's requirements.

B. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

C. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

3.09 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 10mm.

E. Install EPDM rubber lined hangers for hot and cold piping with the following maximum horizontal spacing and minimum rod diameters:
   1. 25mm to 50mm and Smaller: 10-mm rod.
   2. 50mm to 200mm 13-mm rod.

F. Install supports for vertical piping every 1500 mm for 50mm and smaller, and every 1800mm.

G. Install rubber lined hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. 50mm and Smaller: 1200 mm.
   2. 65mm to 150mm 48 inches -1200 mm13-mm rod.

H. Install supports for vertical PVC piping every 1200 mm.

I. Support piping and tubing not listed in this article according to manufacturer's written instructions.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
   4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for 65mm and larger.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Re inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re inspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.14 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball or gate valves for piping 50mm and smaller. Use butterfly, ball, or gate valves with flanged ends for piping 65mm and larger.
2. Hot-Water Circulation Piping, Balancing Duty: balancing valves.
3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

D. PPR valves matching piping materials may be used.

SECTION 221316
FACILITY SANITARY SEWERAGE

SECTION 221316
FACILITY SANITARY SEWERAGE

Part 1 - GENERAL

1.01 SECTION INCLUDES

A. Sanitary Sewerage

B. Approved Manufacturers:

- UPVC
  1. Hepworth
  2. Uponor
  3. George Fisher
  4. Geberit (Switzerland)
  5. Valsir (Italy)
  6. Wavin
     Or approved equal

1.02 RELATED SECTIONS

A. Section 22 4100 Plumbing Fixtures

1.03 REFERENCES

A. BS 743 – Materials for damp-proof courses

B. BS EN 598 - Ductile iron pipes, fittings, accessories and their joints for sewerage applications. Requirements and test methods

C. BE EN 877 - Cast iron pipes and fittings, their joints and accessories for the evacuation of water from buildings. Requirements, test methods and quality assurance.

D. BS 2494 - Specification for elstomeric joint rings for pipework and pipeline

E. BS 2494 – Elastomeric seals for joints in pipework and pipelines

F. BS 4515 – Unplasticised PVC soil and ventilation pipes

G. BS 4660 or to EN standrad - Unplasticized polyvinyl chloride (PVC-U) pipes and plastic fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage

H. BS 5254 or to EN standard– Polypropylene waste pipe and fittings

I. BS 5572 or to EN standard – Sanitary pipework

J. BS 6076 – Tubular polythene film for use as protective sleeving for buried iron pipes and fittings

K. BE EN 12056 - Gravity drainage systems inside buildings.

1.04 SUBMITTALS

A. See Section 01 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on piping, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Shop Drawings:
   1. Submit preliminary layout of finished ceiling areas indicating only piping locations coordinated with ceiling installation.
   2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.
   3. Submit shop drawings to authority having jurisdiction for approval. Submit proof of approval to.

D. Project Record Documents: Record actual locations of piping and deviations of piping from drawings. Indicate drain and test locations.

E. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

F. Each type of imported pipe bedding material.

G. Each type of filter material.

1.05 QUALITY ASSURANCE

A. Maintain one copy of referenced design and installation standard on site.

B. Conform to UL requirements.

C. Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in Dubai..

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

E. Installer Qualifications: Company specializing in performing the work of this section with minimum five years' experience approved by manufacturer.

F. It is the responsibility of this Contractor to make a detailed review of all drawings during the tender period, in order to fully comprehend the extent of the work to be completed. These drawings are schematic in nature and show the intent for the minimum requirements of the systems. Obstructions to pipe routing and obstructions to the location of piping are not shown on these drawings. It is this

Contractor's responsibility to locate and detail these obstructions as part of the scope of work. In addition it is this Contractor's responsibility to acquaint himself of all the drawings from the other disciplines – structural, electrical, and mechanical, during the tender phase, so that all of the interferences can be appreciated at the time of tender. No extras will be given for conditions that were known at the time of tender.

G. Give sufficient notice so that inspection may be made at the following stages
   1. Excavated surfaces
   2. Concealed or underground services.

1.06 PRE-INSTALLATION MEETING

Convene one week before starting work of this section.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.08 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 SANITARY, WASTE, CONDENSATE, AND VENT PIPING at the risers and unoccupied spaces

A. PVCu Soil & waste systems shall be manufactured to BS EN 1329 :2000 formerly BS4514 & BS 5255.

B. All pipes and fittings shall strictly comply to the requirements of BSEN 1329 and carry the British Standard Kite mark where appropriate. Pipes and fittings shall be manufactured at the same manufacturing location and under the same quality control system.

C. Soil & Vent pipes, sizes 160mm, 110mm & 82mm shall be manufactured using PVCu with ring seal joints that will allow for expansion and contraction within the system.

D. Waste pipes, 50mm and below shall be manufactured from either High Temperature resistant MUPVC to BS EN 1566 or ABS to BS EN 1455 – 1: 200 with solvent weld joints. Where appropriate, all pipes and fittings shall carry the British Standard Kite mark and be manufactured under a single quality control regime in the same location.

E. Soil & Waste pipe sizing will reflect the number of discharge units that drain into the system as laid down by BS EN12056 – 2.

2.02 SANITARY, WASTE DRAINAGE AT occupied spaces (Not applicable)

A. Pipes and fittings used for the drainage should be made of sound proof piping system made from mineral supplemented polypropylene. The pipes should consist of three homogenous layers (polypropylene- mineral additives-polypropylene) with a sound insulation layer density must be 1.9gr/cm3.

B. Sound proof material should be tested and approved by the German standard DIN 52219: 1993-07 & DIN EN 14366 with a sound level not exceeding 16 dBA in the structure- born test and not more than 16dBA in the basement test-room UG rear without clamps.

2.03 KITCHEN WASTE PIPING FOR RESTAURANTS and f&b areas. (Not Applicable)

A. HDPE pipes shall stand for High Density Polyethylene with SDR 26 shall be used with fusion welded fittings to manufacturer's recommendations. Polyethylene is a semi crystalline thermoplastic that can have different densities. By coloring with 2% of "carbon black" the PE gets its black color.

B. HDPE has a high resistance against acids, bases and aqueous salt-solutions. Below 60°C it is practically unsolvable in organic solutions. The pipes and fittings shall conform the EN1519 specifications as below:

2.04 PIPE HANGERS AND SUPPORTS

A. For Drain, Waste, and Vent Pipe:
1. Hangers for Pipe Sizes 15 mm to 40 mm: Malleable iron, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support for Pipe Sizes to 80 mm: Cast iron hook.
5. Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
9. Construction of brackets and hanger exposing to weather shall be of stainless steel grade 316.

Part 3 - EXECUTION

3.01 SANITARY DRAINAGE

A. Laying
Lay in straight lines between changes in direction or grade with sockets pointing up hill. If other pipes are adjacent, set each pipe true to line and complete each joint before laying the next pipe. If work is not continuous cap open ends to prevent entry of foreign matter.

B. Identification
Lay a detectable strip or plastic tape in the trench after pipe laying, testing and initial backfilling.

C. Pipe underlay
Bed piping on a continuous underlay of bedding material, at least 75 mm thick after compaction. Grade the underlay evenly to the gradient of the pipeline.
If necessary, form chases to prevent projections such as sockets and flanges from bearing on the trench bottom or underlay.

D. Pipe surrounds
Place the material in the pipe surround in layers □ 200 mm loose thickness, and compact without damaging or displacing the piping.

E. Anchor blocks
If necessary to restrain lateral and axial movement of the stormwater pipes provide reinforced concrete anchor blocks at junctions and changes of grade or direction. The top face of each block shall be covered with two layers of compressible packing complying with BS 743.

F. Encasement
Encase the pipeline in concrete at least 150 mm above and below the pipe, and 150 mm each side or the width of the trench, whichever is the greater. Where pipes with flexible joints are used, the concrete protection shall be interrupted over its full cross-section ate each pipe joint by a shaped compressible filler of bitumen impregnated insulating board to BS 1142 or equally compressible material.

G. Thermal movement
Arrange piping to accommodate thermal expansion. Provide proprietary expansion joints where pipe flexibility is not sufficient to absorb movement. Make sure that movement does not strain branch connections.

3.02 PIPING

A. Finishes
Finish exposed piping, including fittings and supports, as follows:

1. In internal locations such as toilet and kitchen areas shall be chrome plate copper piping.

2. Externally, and steel piping and iron fittings internally shall be painted.

3. In concealed but accessible spaces (including cupboards and non-habitable enclosed spaces) the contractor may leave copper and plastic unpainted except for identification marking. Prime steel piping and iron fittings.

B. Finish valves to match connected piping.

C. Conform to the Pipe support schedule.

D. Tolerances
Conform to the Pipeline tolerances table. These tolerances are conditional on falls to outlets being maintained and no part of a pipeline being at less than the designated gradient.

	Permissible angular deviation from alignment	Permissible displacement from alignment
Horizontal	1 in 300	15 mm
Vertical	1 in 300	5 mm

E. Acoustic Insulation
All waste and drainage pipes between residential units particularly when crossing noise sensitive spaces from different occupancies shall be externally wrapped with acoustic insulation. Refer to Section 22 0719 Plumbing Piping Insulation.

3.03 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 15 mm space between finished covering and adjacent work.

C. Place hangers within 300 mm of each horizontal elbow.

D. Use hangers with 40 mm minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

E. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.04 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage

3.05 COMPLETION

A. On com pletion clean and flush the whole installation.

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Through-penetration fire stop assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.
7. Trench drain
8. Roof drain

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.10 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Floor Cleanout type FCO-1: to comprise PVC plugs with heavy duty PVC or stainless steel access cover similar to NICOLL, DALLMER, JOHNSPEC or approved equal.

2.2 FLOOR DRAINS

A. Floor drain type FD-1: PVC or stainless steel type, to have round flat strainer as manufactured by Nicoll or approved equal. Combined floor drain and integral trap seal to have 3 x 50 auxiliary side inlets and 75 mm side outlet, adjustable strainer permitting vertical adjustment of strainer height without disturbing flooring or connection during installation. As manufactured by Nicoll Dallmer or Josam or approved equal. Strainer body is to permit installation of different interchangeable strainer variations on same floor drain, and when needed to fit into an adjustable PVC extension collar. Access to the trap seal is to be made possible through a 12.5mm diameter opening fitted with a plastic cleanout plug.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

      a. Acorn Engineering Company; Elmdor/ Stoneman Div.
      b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm) thick, lead flashing collar and skirt extending at least 10 inches (250 mm) from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.
   1. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Fire stop Assemblies :

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

      a. Pro Set Systems Inc.

   2. Standard: UL 1479 assembly of sleeve and stack fitting with fire stopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   5. Special Coating: Corrosion resistant on interior of fittings.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
    b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings :

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device :

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend **1 inch (25 mm)** above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings :

1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Vent Caps

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

G. Expansion Joints :

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Solder: ASTM B 32, lead-free alloy.

F. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 TRENCH DRAIN MATERIALS

A. TRENCH Drains:
1. Standard: ASME A112.6.3 for trench drains
2. Material: Ductile or gray iron
3. Flange: required
4. Clamping Device: required
5. Outlet: Bottom
6. Grate Material: Ductile iron or gray iron, stainless steel
7. Grate Finish: To the Architectural finishes

2.8 ROOF DRAIN MATERIALS:

PVC dome strainer materials will be installed where opening are available in gutter drains to efficiently collect rain water from gutters while preventing debris, leaves, and other solids from entering inside pipes. Typically made of durable plastic. The drain features a perforated or mesh strainer that sits at the roof surface to filter out layer particules.
Strainer roof drains are often equipped with clamping rings or removable covers to allow easy cleaning and maintenance.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain unless otherwise indicated.

F. Install stack air-admittance valves at top of stack vent and vent stack piping.

G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

I. Install deep-seal traps on floor drains and other waste outlets, if indicated.

J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

K. Install vent caps on each vent pipe passing through roof.

L. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

B. Set flashing on floors and roofs in solid coating of bituminous cement.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Section "Sheet Metal Flashing and Trim."

E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.6 DEMONSTRATION

A. Train Employer's maintenance personnel to adjust, operate, and maintain the drainage specialties systems

SECTION 223300
ELECTRIC WATER HEATERS

SECTION 223300
ELECTRIC WATER HEATERS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electric storage-type domestic water heaters.
2. Factory-applied thermal insulation.
3. Electric immersion heating elements.
4. Temperature and pressure relief valve.
5. Thermostat and safety controls.
6. Magnesium sacrificial anode.
7. Drain valve.
8. Mounting accessories.
9. Electrical connections.
10. All accessories required for complete installation.

1.2 RELATED SECTIONS

- Division 22 – Common Plumbing Requirements
- Section 22 05 23 – General Duty Valves
- Section 22 05 29 – Hangers and Supports
- Section 22 05 53 – Identification
- Section 26 05 00 – Electrical

1.3 REFERENCES

Equipment shall comply with the latest editions of:

- ISO 9001
- IEC 60335
- IEC 60529
- IEC 60204
- EN 60335
- NSF/ANSI 61
- Local Electrical Code
- ASHRAE 90.1
- UL 174 or UL 1453 as applicable for electric water heaters.
- International Mechanical Code (IMC)
- International Plumbing Code (IPC)

Electric water heaters shall be listed and labeled for potable water service and installed in accordance with applicable plumbing and mechanical codes.

1.4 SUBMITTALS

Submit:

A. Product Data.
Include:

- Manufacturer
- Model
- Capacity
- Dimensions
- Electrical characteristics
- Heating capacity
- Insulation thickness
- Storage tank construction
- Wiring diagram

B. Shop Drawings
Showing:

- Installation details
- Clearances
- Supports
- Plumbing connections
- Electrical connections

C. Manufacturer certificates.
D. Test certificates.
E. Warranty.
F. Operation and Maintenance Manuals.

1.5 QUALITY ASSURANCE

Manufacturer shall have:

- Minimum 10 years manufacturing experience.
- ISO 9001 certified manufacturing facility.

Products shall be factory assembled and factory tested.

1.6 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Subject to compliance with this Specification:

- A.O. Smith
- Ariston
- Atlantic
- Bosch
- Rheem
- Ferroli
- Tesy
- Thermor
- Elbi
- Equivalent approved

2.2 STORAGE TYPE ELECTRIC WATER HEATER

The water heater shall be factory assembled vertical storage type suitable for potable domestic hot water.

Capacity
Storage Capacity: **100 Liters**

Installation
Vertical wall-mounted

Storage Tank

- Heavy gauge steel construction
- Glass-lined enamel internal coating
- Corrosion resistant
- Suitable for potable water
- Maximum working pressure: **8–10 bar**

External Casing

- Powder coated steel
- White finish
- Corrosion resistant

Thermal Insulation

- High density polyurethane foam
- CFC free
- Injected insulation

Minimum insulation thickness:**40–50 mm**
Density:**40 ±5 kg/m³**
Maximum standing heat loss:Comply with ErP Energy Class C or better.

Heating Element

Type: Copper sheathed immersion element

Power:**1.5 kW minimum**

Supply Voltage:

- **230V**
- Single Phase
- 50 Hz

Thermostat

Adjustable
Temperature range:35°C–75°C
Factory preset:60°C
Accuracy:±3°C

High Temperature Protection

Manual reset safety thermostat.
Maximum trip temperature:95°C

Internal Anode

Factory installed magnesium sacrificial anode.
Replaceable.

Temperature & Pressure Relief Valve

Factory supplied.
Pressure setting:8 bar
Temperature setting:99°C
Complete with discharge connection.

Drain Valve

Factory supplied.
Minimum size: ½"

Connections

Cold water: ½"
Hot water: ½"

Electrical Protection:

Degree of Protection: Minimum **IP54**

Energy Performance

Energy Class: Minimum
ERP Class C
Preferred:**ERP Class B**

Maximum Working Pressure: 6–8 bar

Test Pressure: Minimum:10 Bar

Operating Temperature: Maximum: 75°C

Electrical Cable

Factory terminal block.
Complete with earth connection.

Accessories

Provide:

- Safety valve
- Drain valve
- Magnesium anode
- Adjustable thermostat
- High limit thermostat
- Wall mounting brackets
- Expansion anchors
- Installation template
- Thermometer (if available)

2.3 PERFORMANCE REQUIREMENTS

Tank shall withstand continuous operation at rated pressure.
Heating element shall be removable without replacing tank.
Standby heat losses shall comply with current energy efficiency requirements.

PART 3 – EXECUTION

3.1 INSTALLATION

Install in accordance with:
- Manufacturer recommendations
- IPC
- Local Authority requirements

Provide:
- Isolation valve
- Check valve
- Safety valve
- Drain connection
- Flexible connectors (where indicated)

3.2 ELECTRICAL CONNECTIONS

Electrical installation shall comply with IEC requirements.

Provide:

- Local isolator
- MCB
- Earth connection
- Residual Current Device (RCD)

3.3 TESTING

After installation:

- Fill tank completely.
- Vent all air.
- Pressure test.
- Verify no leakage.
- Check thermostat operation.
- Check safety thermostat.
- Check heating element.
- Verify electrical current.
- Verify insulation resistance.
- Demonstrate satisfactory operation.

3.4 COMMISSIONING

Commission complete system including:

- Thermostat adjustment
- Safety devices
- Heating cycle
- Water temperature
- Electrical load
- Leakage inspection

3.5 CLEANING

Remove all debris.
Clean equipment.
Leave unit ready for operation.

SECTION 224100
PLUMBING FIXTURES

SECTION 224100
PLUMBING FIXTURES

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
1. Floor-mounted water closets with accessories.
2. Semi-pedestal lavatories with accessories.
3. Shower heads and shower mixer sets.
4. Fixture supports, trim, fittings, and installation accessories.

1.2 REFERENCES

Comply with the latest editions of:
- ASME A112.19.2 – Ceramic Plumbing Fixtures.
- ASME A112.18.1/CSA B125.1 – Plumbing Supply Fittings.
- ASME A112.4.2 – Water Closet Supports.
- NSF/ANSI 61 – Drinking Water System Components.
- NSF/ANSI 372 – Lead-Free Plumbing Products.
- EN 997 – WC Pans and WC Suites.
- EN 14688 – Wash Basins.
- EN 1111 / EN 817 – Mixing Valves.

1.3 SUBMITTALS

Submit:
- Manufacturer's Product Data.
- Technical Data Sheets.
- Shop Drawings.
- Color Samples.
- Operation and Maintenance Manuals.
- Warranty Certificate.

1.4 QUALITY ASSURANCE

Fixtures and fittings shall be manufactured by firms having a minimum of five (5) years' experience and shall be new, free from defects, and listed for potable water service.

1.5 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with the Specification, provide one of the following:

- Geberit
- Ideal Standard
- Grohe
- Duravit
- Roca
- Villeroy & Boch
- Kohler
- TOTO
- American Standard
- Equivalent approved.

2.2 FLOOR-MOUNTED WATER CLOSET (EWC)

A. General

Provide vitreous China, floor-mounted, close-coupled or back-to-wall water closet suitable for commercial and residential applications.

B. Construction

- Vitreous China.
- White glazed finish.
- Wash-down or siphonic flushing action.
- Horizontal outlet unless otherwise indicated.
- Floor-mounted installation.

C. Performance

- Flush Volume: **Dual Flush 3/6 L** (preferred) or **Single Flush 6 L**.
- Rimless bowl preferred.
- Fully glazed internal trap way.

D. Seat

Provide heavy-duty:

- Thermoset plastic seat.
- Soft-closing.
- Quick-release hinges.
- Stainless steel hinges.

E. Accessories

Provide complete with:

- Concealed cistern or exposed dual-flush cistern as indicated.
- Dual-flush actuator plate or flush button.
- Angle stop valve.
- Flexible braided connector.
- Floor fixing bolts.
- Wax seal or neoprene gasket.
- Chrome-plated escutcheon.
- All fittings necessary for complete installation.

2.3 SEMI-PEDESTAL LAVATORY

A. General
Provide wall-hung vitreous China lavatory complete with matching semi-pedestal.

B. Construction
- Vitreous China.
- White glazed finish.
- Overflow opening.
- One faucet hole unless otherwise indicated.

C. Faucet
Provide chrome-plated single-lever mixer complete with:
- Ceramic cartridge.
- Flexible braided hoses.
- Flow regulator (maximum 5–6 L/min).
- Aerator.
- Fixing kit.

D. Accessories
Provide complete with:
- Chrome-plated bottle trap (32 mm).
- Chrome-plated angle valves.
- Flexible connectors.
- Pop-up waste.
- Overflow fitting.
- Wall fixing brackets.
- Silicone sealant.
- Semi-pedestal.
- All accessories required for complete installation.

2.4 SHOWER HEAD AND SHOWER MIXER

A. Shower Head
Provide chrome-plated fixed wall-mounted shower head:

- Flow Rate: **Maximum 8–9 L/min**
- Anti-limescale silicone nozzles.
- Adjustable spray pattern.
- Minimum operating pressure: **1.0 bar**
- Maximum operating pressure: **5.0 bar**

B. Shower Mixer
Provide concealed or exposed single-lever shower mixer as indicated:

- Brass body.
- Chrome-plated finish.
- Ceramic disc cartridge.
- Pressure balanced.
- Hot water temperature up to 70°C.
- Operating pressure: 1–5 bar.

C. Accessories

Provide complete with:

- Shower arm.
- Wall flange.
- Shower hose (if hand shower type).
- Hand shower and wall bracket where indicated.
- Connection fittings.
- Escutcheons.
- Concealed installation box where required.
- Isolation valves.
- All accessories necessary for complete installation.

PART 3 – EXECUTION

3.1 INSTALLATION

Install fixtures in accordance with the manufacturer's written instructions and approved shop drawings.

Provide all supports, anchors, seals, trims, and accessories required for a complete installation.

3.2 FIELD QUALITY CONTROL

- Verify proper alignment and secure fixing.
- Test all water supply and waste connections for leakage.
- Verify proper flushing and drainage.
- Check mixer operation, water flow, and temperature control.
- Adjust flush valves and flow regulators as required.

3.3 CLEANING AND PROTECTION

- Clean all fixtures after installation.
- Remove labels and protective coverings.
- Protect fixtures from damage until Substantial Completion.
- Replace damaged or defective fixtures before final acceptance.

SECTION 231113
FUEL OIL SYSTEM

SECTION 231113
FUEL OIL SYSTEM

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section shall cover the furnishing of all materials, labour, equipment and accessories necessary to the installation of fuel oil system, as shown on the Drawings and specified herein.

B. The extent of work shall include, but not necessarily limited to, fuel oil piping, storage tanks, pumps, meters, strainers, couplings, and all related accessories.

1.02 QUALITY ASSURANCE

A. Applicable Codes and Standards: NFPA 30. or equivalent BS standard.

B. Manufacturers: Firms regularly engaged in manufacture of fuel oil piping and equipment, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

C. Tests: Upon completion of works, systems shall be run in presence of the Engineer and proof shall be made that every system and component is operating in accordance with the drawings and specifications requirements.

D. Corrosion Prevention: Except as otherwise specified herein, equipment fabricated from ferrous metals shall be treated for prevention of corrosion by a factory coating or paint system.

1.03 SUBMITTALS

A. Manufacturer's Literature:

1. Required data shall include, but not necessarily be limited to:

   a. Manufacturer's name and model number.

   b. Equipment: Size, capacity, performance, materials and methods of construction, weight, electrical and mechanical connections, and installation recommendations.

B. Shop Drawings: Submit shop drawings for required fuel oil piping and equipment showing pipe and tube sizes; plan and elevation of pumps and integral component parts and auxiliary equipment including fittings and piping connections.

C. Recommended Spare Parts List: Submit list of recommended spare parts for each unit furnished under this Section. List shall include part numbers, a description of each part, and the price of each part.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be delivered with factory-installed shipping skids. Accessories shall be packed in factory-fabricated fiberboard containers and with plastic end-cap protection on each end of pipe and tube to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Equipment and piping shall be handled carefully to avoid damage to components, enclosures and finishes. Damaged equipment shall not be installed. Damaged equipment shall be returned to manufacturer and replaced by new ones.

C. Equipment and piping shall be stored inside and protected from weather and construction traffic.

1.05 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

PART 2 - PRODUCTS

2.01 FUEL OIL PIPING PRODUCTS

A. General: Provide factory-fabricated piping products of the size and type indicated. Where not otherwise indicated, provide products as determined by the Contractor to comply with installation requirements. Provide sizes and types matching piping and equipment connections.

B. Approved Manufacturers:
1. OPW, U.S.A.
2. Dyna Fab, U.S.A.
3. Viega, U.S.A.
Or approved equal

C. Pipes: Fuel oil piping shall be seamless black steel, Schedule 40 to ASTM A53/A106 grade B or BS1387 or approved equal.. Underground fuel piping shall be outside coated in accordance with AWWA C203.

D. Fittings: Buried fittings shall be forged steel socket welding fittings having a working pressure equal or higher than the above specified pipe. Above ground fittings shall be malleable iron threaded ends up to 50 mm diameter and forged steel welding type for 65 mm diameter and above.

E. Valves:
1. Pressure relief valves
2. Oil safety valves
3. Emergency shutoff valves (bronze bull valves with bronze trim)
4. Mechanical leak detection

2.02. FUEL OIL TANK

A. Approved Manufacturers:
1. Plasteel
2. Gulf Eternite
3. Viega US.A.
Or approved equal

B. ABOVE GROUND FUEL OIL TANK

Tank shall be constructed of not less than 4 mm. thick welded black steel sheet metal to the capacities indicated on Drawings, and in accordance with UL standard for steel above ground tanks for flammable and combustible liquids .UL. 142-1972.

Tank shall be tested for leaks before installation and shall be painted with two coats of red lead oxide or approved equal, and two coats black bituminous paint, and finished with Silver or White enamel paint.

Tanks shall be mounted on a concrete pad and an angle supported steel base above ground.

The tank shall be complete with the following connections and fittings:

- Screened air vent.
- Fill line inlet complete with isolation valve.
- Suction line feeder to generator complete with isolating valve.
- Return line from generator.
- Sludge drain valve.
- Protected oil level indicator fixed to the tank.
- Level switch sensor
- Digital level indicator
- 600 mm diameter or rectangular access openings. Each opening is to be fitted with a raised flanged lid securely hinged to the tank and sealed by gasket to provide tight joint against water admittance.

C. FILTERS

Dual type oil filters shall be fitted on the inlet side of the pumps.
The filters shall be equipped with a central changeover cock to permit isolation of either filter chamber and allow flow to continue.

The filters shall be line size, tested to 20.6 bar and shall have gunmetal body and covers, stainless steel internals with a stainless steel mesh element and be complete with brass drain plug. The elements shall be capable of filtration down to 100 microns.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM

General: Comply with the requirements of Division 15 sections for installation of basic piping materials. Install piping products in accordance with the manufacturer's written instructions, the applicable requirements of NFPA 30, and in accordance with recognized industry practices to ensure that products serve the intended function.
Remove cutting and threading burrs before assembling piping.
Do not install defective piping of fittings. Do no use pipe with threads, which are chipped, stripped or damaged.
Install fuel oil tank with anode in accordance with NFPA 30 and as shown on drawings.
Ground fuel oil piping system electrically within project, and bond to grounding electrode.

Prepare the exterior surfaces for painting by the complete wire brushing for removal of mill scale, rust, welding slag and other surface contaminants to leave a surface of uniform appearance, suitably roughened to receive the coating herein specified. After tank has been assembled, clean the surfaces of the tank thoroughly from all dirt debris. All surfaces shall be cleaned to bright metal and entire exposed surface shall receive two coats of coal tar primer and enamel.

Each coat shall be no less than 0.2 mm thick. Apply coal tar in strict accordance with the manufacturer’s instructions.

Coat all steel tank appurtenances such as hold down rods, turn buckles, etc., as herein specified for tank.

Handle tank in a manner which will preclude damage to the coating by impact or abrasion. After installation and prior to backfilling, tank shall be pressure-tested and proved tight at 35 Kpa pressure. Backfill shall be compacted thoroughly with care exercised to avoid damage to the tank’s coating; all foreign material such as bricks, gravel, etc., shall be thoroughly screened from backfill. Backfill material shall be thoroughly and mechanically tamped in courses of 30cm, with care exercised to avoid damage to tank covering. Backfill must not contain any ash, cinders, ironite, or other corrosive materials.

3.02 PROTECTION OF FUEL OIL PIPING AGAINST CORROSION

Protect metal fuel oil piping in contact with the earth, or other corrosive material, against corrosion. Seal wrap piping with coal tar saturated wrapping tape over coal-tar epoxy coating having not less than 0.5 mm thickness.

3.03 PROTECTION OF FUEL OIL TANKS AGAINST CORROSION

Protect fuel oil supply tanks against corrosion by installing protective finish or coating as recommended by the manufacturer.
Repair factory-applied external tank coating by touching-up those surfaces, which were chipped, scratched, or damaged during transit.

3.04 EQUIPMENT CONNECTIONS

General: Connect fuel oil piping to equipment in the manner shown and comply with equipment manufacturer's instructions where not otherwise indicated.

3.05 FIELD QUALITY CONTROL

A. Fuel Oil Piping Tightness Test: Prior to initial operation, test fuel oil piping in accordance with NFPA 30.

B. Repair or replace fuel oil piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

SECTION 233113
METAL DUCTS

SECTION 233113
METAL DUCTS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
1. Galvanized steel air ducts.
2. Duct fittings and transitions.
3. Flexible duct connections.
4. Duct supports and hangers.
5. Access doors.
6. Volume control dampers.
7. Sealants and accessories.

1.2 REFERENCES

Comply with the latest editions of:
- SMACNA – HVAC Duct Construction Standards.
- ASHRAE Handbook – HVAC Systems and Equipment.
- ASTM A653/A653M – Galvanized Steel Sheet.
- ASTM A924 – Steel Sheet Metallic Coated.
- NFPA 90A – Air Conditioning and Ventilating Systems.
- DW/144 (where applicable).

1.3 SUBMITTALS

Submit:
- Manufacturer's Product Data.
- Duct Fabrication Details.
- Shop Drawings.
- Leakage Class Certification.
- Material Certificates.
- Operation and Maintenance Manuals.

1.4 QUALITY ASSURANCE

A. Fabricate ducts in accordance with SMACNA.
B. Use factory galvanized steel sheet with minimum G90 (Z275) zinc coating.

1.5 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- Duct fabricated by approved specialist manufacturer.
- Lindab
- Kingspan
- Metalaire
- Approved Equivalent.

2.2 GALVANIZED STEEL DUCTWORK

A. Material

- Hot-dip galvanized steel sheet.
- Zinc coating: **G90 (Z275) minimum**.
- Lock-formed construction.
- Reinforced in accordance with SMACNA.

B. Minimum Sheet Thickness

Longest Duct Side	Thickness
Up to 300 mm	0.60 mm
301–750 mm	0.80 mm
751–1500 mm	1.00 mm
Above 1500 mm	1.20 mm

C. Construction

Provide:

- Pittsburgh lock seams.
- Reinforcement as required by SMACNA.
- Airtight joints.
- Turning vanes.
- Radius elbows.
- Flexible canvas connections.
- Access doors.
- Volume control dampers.
- Hangers and supports.
- Duct sealant complying with SMACNA Seal Class A.

D. Pressure Class

- Low Pressure: ±500 Pa
- Medium Pressure: ±1000 Pa
- High Pressure: As indicated on drawings.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install ductwork in accordance with SMACNA and manufacturer's recommendations.
B. Seal all joints to SMACNA Seal Class A.
C. Support ducts with galvanized steel hangers and threaded rods.
D. Install access doors adjacent to all dampers and equipment.
E. Install flexible connections at fans and AHUs.

3.2 FIELD QUALITY CONTROL

- Inspect duct joints.
- Verify supports.
- Perform leakage testing where specified.
- Repair damaged galvanizing using zinc-rich paint.

3.3 CLEANING

Clean ductwork internally before commissioning.

SECTION 23 33 13
MOTORIZED FIRE DAMPERS

SECTION 23 33 13
MOTORIZED FIRE DAMPERS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
1. Motorized fire dampers.
2. Combination fire/smoke dampers.
3. Electric actuators.
4. Sleeve assemblies.
5. Retaining angles.
6. Installation accessories
.

1.2 REFERENCES

Comply with the latest editions of:
- NFPA 80.
- NFPA 90A.
- UL 555 – Fire Dampers.
- UL 555S – Smoke Dampers.
- AMCA 500-D.
- IEC 60335.

1.3 SUBMITTALS

Submit:
- Product Data.
- UL Certificates.
- Shop Drawings.
- Wiring Diagrams.
- Actuator Data.
- O&M Manuals.

1.4 QUALITY ASSURANCE

Fire dampers shall be UL Listed and installed in accordance with NFPA 80 and the manufacturer's instructions.

1.5 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- Ruskin
- Greenheck
- TROX
- Halton
- Nailor
- Aldes
- Approved Equivalent.

2.2 MOTORIZED FIRE DAMPERS

A. General
Provide UL-listed motorized fire dampers for installation in fire-rated walls and floors.

B. Construction
- Galvanized steel frame.
- Galvanized steel blades.
- Stainless steel blade axles.
- Low leakage blade seals.
- Dynamic rated.
- Minimum **2-hour fire rating** unless otherwise indicated.

C. Actuator
- Electric spring-return actuator.
- **24 VAC/DC** or **230 VAC** as scheduled.
- Fail-safe operation.
- Position indication.
- End switches.
- Manual override.

D. Performance
- Fire Rating: **2 Hours minimum**.
- Leakage: UL 555S Class I or II.
- Velocity Rating: **Up to 20 m/s**.
- Pressure Rating: **2000 Pa minimum**.

E. Accessories
Provide:
- Factory sleeve.
- Retaining angles.
- Breakaway duct connections.
- Access door.
- Thermal fuse.
- Junction box.
- Flexible conduit.
- Mounting hardware.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install fire dampers where ducts penetrate fire-rated walls, floors, shafts, and partitions.
B. Install in accordance with NFPA 80, UL listings, and the manufacturer's installation instructions.
C. Connect motorized dampers to the fire alarm and building management system where indicated.
D. Provide access panels for inspection and maintenance.

3.2 FIELD QUALITY CONTROL

A. Verify actuator operation.
B. Test opening and closing sequence.
C. Verify operation upon fire alarm signal and power failure.
D. Inspect installation before concealment.

3.3 CLEANING AND PROTECTION

A. Clean dampers after installation.
B. Protect dampers from dust and construction debris until final acceptance.

SECTION 233416
HVAC FANS

SECTION 233416
HVAC FANS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:
1. Wall-mounted axial exhaust fans.
2. Floor-standing ducted centrifugal exhaust fans for roof installation.
3. Flexible duct connections, vibration isolation, roof curbs, weather hoods, dampers, and all accessories required for a complete installation.

1.2 REFERENCES

Comply with the latest editions of the following standards:
- AMCA 99 – Standards Handbook.
- AMCA 210 – Laboratory Methods of Testing Fans.
- AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
- AMCA 301 – Certified Ratings Program.
- UL 507 – Electric Fans.
- IEC 60034 – Rotating Electrical Machines.
- ISO 5801 – Fan Performance Testing.
- ISO 14694 – Industrial Fans – Specifications for Balance Quality and Vibration Levels.

1.3 SUBMITTALS

Submit:
A. Manufacturer's Product Data.
B. Fan Performance Curves.
C. Sound Power Data.
D. Electrical Characteristics.
E. Shop Drawings.
F. Operation and Maintenance Manuals.
G. Warranty Certificate.

1.4 QUALITY ASSURANCE

A. Fans shall be factory assembled and factory tested.
B. Performance ratings shall be AMCA certified where applicable.
C. Motors shall comply with IEC requirements and be suitable for continuous duty.

1.5 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Subject to compliance with this Specification, provide one of the following:

- Soler & Palau (S&P)
- Systemair
- Greenheck
- Nicotra Gebhardt
- Rosenberg
- Fantech
- Vent-Axia
- Maico
- Approved Equivalent.

2.2 WALL-MOUNTED AXIAL EXHAUST FAN

A. General

Provide factory-assembled wall-mounted axial exhaust fan suitable for toilets, bathrooms, kitchens, laundry rooms and utility spaces.

B. Construction

1. UV-stabilized ABS or polypropylene housing.
2. Aerodynamically balanced axial impeller.
3. Corrosion-resistant construction.
4. Integral gravity backdraft shutter.
5. Suitable for continuous operation.
6. Wall-mounted installation.

C. Motor

1. Direct-drive motor.
2. Permanently lubricated sealed bearings.
3. Thermal overload protection.
4. Single Phase, 230 V, 50 Hz.
5. IPX4 minimum.
6. Insulation Class B minimum.

D. Performance

- Air Capacity: As scheduled.
- Static Pressure: Minimum 25 Pa.
- Maximum Sound Level: **40 dB(A)** at 3 m.
- Maximum Operating Temperature: **40°C**.

E. Accessories

Provide complete with:

1. PVC duct connection.
2. Gravity backdraft damper.
3. Exterior weather louver.
4. Insect screen.
5. Wall sleeve.
6. Mounting hardware.

F. Standard Outlet Sizes

- Ø100 mm
- Ø125 mm
- Ø150 mm

2.3 FLOOR-STANDING DUCTED CENTRIFUGAL EXHAUST FAN (ROOF MOUNTED)

A. General

Provide heavy-duty floor-standing centrifugal duct fan suitable for roof installation and continuous operation.

B. Construction

1. Heavy-gauge galvanized steel housing.
2. Backward-curved centrifugal impeller.
3. Dynamically balanced impeller.
4. Structural steel base frame.
5. Weatherproof construction.
6. Hinged inspection access door.
7. Outdoor duty.

C. Motor

1. Totally Enclosed Fan Cooled (TEFC).
2. IE3 Premium Efficiency.
3. Three Phase, 400 V, 50 Hz.
4. IP55 minimum.
5. Insulation Class F.
6. Suitable for VFD operation.
7. Direct-drive or belt-drive as scheduled.

D. Performance

- Air Capacity: As scheduled.
- Static Pressure: As scheduled.
- AMCA certified performance.
- Maximum Continuous Operating Temperature: **60°C**.

E. Accessories

Provide complete with:

1. Flexible canvas connectors.
2. Spring vibration isolators.
3. Weatherproof roof curb.
4. Weatherproof discharge hood.
5. Bird screen.
6. Backdraft damper.
7. Anchor bolts.
8. Drain connection.
9. Lifting lugs.
10. Outlet flange.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install fans in accordance with the manufacturer's written instructions and approved shop drawings.

B. Securely mount wall-mounted fans with airtight PVC duct connections and weatherproof external louvers.

C. Install roof-mounted centrifugal fans on reinforced roof curbs complete with spring vibration isolators, flexible duct connectors and weatherproof flashing.

D. Provide sufficient access for inspection, servicing and motor replacement.

E. Connect electrical power and controls in accordance with Division 26.

3.2 FIELD QUALITY CONTROL

A. Verify fan rotation.
B. Measure airflow and static pressure.
C. Verify motor voltage and current.
D. Check vibration and noise levels.
E. Demonstrate satisfactory operation under design operating conditions.

3.3 CLEANING AND PROTECTION

A. Clean fan housings, impellers and accessories after installation.
B. Remove debris from duct connections.
C. Protect installed equipment from damage until final project acceptance.

SECTION 233713
AIR OUTLETS

SECTION 233713
AIR OUTLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

B. Register: A combination grille and damper assembly over an air opening.

1.3 SUBMITTALS

A. Product Data: For each model indicated, include the following:

1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
3. Schedule of air outlets indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of air outlets with other items installed in ceilings and walls.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for air outlets with factory-applied color finishes.

D. Samples for Verification: air outlets in manufacturer's standard sizes, showing the full range of colors. Prepare Samples from the same material to be used for the Work.

E. Source quality-control reports.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of air outlets and are based on the specific requirements of the systems selected. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Product Requirements."

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

1.5 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following or approved equal:

1. Trox – Germany
2. Systemair- Sweden
3. Titus – USA
4. Nailor Industries- Canada
5. Halton – Finland
6. Ruskin – USA
7. KBE- Lebanon

2.2 AIR-DIFFUSION DEVICE CONSTRUCTION

A. Air-diffusion device construction and mounting shall preclude flutter, rattle, or vibration. Devices shall have the modifications and accessories necessary for mounting in indicated surface construction.

B. Color selection shall be as directed by the Engineer.

C. Air-diffusion shall be provided with combination damper and equalizing grid. Dampers shall be extracting-splitter type, except as otherwise indicated.

D. Air-diffusion shall be selected to give required throw to nearest wall. Terminal velocity is not to exceed 0.5 m/s specified air quantity. Velometer velocities through diffuser are not to exceed 3.0 m/s. Supply diffusers are to be able to deliver air for cooling at 15 deg. C below room temperature without causing objectionable conditions.

E. Air-diffusion device volume and pattern adjustments shall be made from the face of the device.
Volume adjustments shall be made by **removable key**.

F. Gaskets shall be provided for supply-terminal air devices mounted in finished surfaces.

G. Exterior and exposed edges shall be rolled, or otherwise stiffened and rounded.

H. For ductwork of pressure classes 1000 to 2500 Pa (4 to 10 inch water gage), provide sponge- rubber gasket between flanges and wall or ceiling.

I. Size air outlets for minimum noise levels, not to exceed 30 db at specified air quantity, as measured on the A-scale of a standard noise level meter, unless specified otherwise.

2.3 SOURCE QUALITY CONTROL

A. Testing: Test performance according to ASHRAE 70, "Method of Testing the Performance of Air Outlets and Air Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where air outlets are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install air outlets level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Install air outlets with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust air outlets to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

A. After installation of air outlets inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace air outlets that have damaged finishes.

3.5 REGISTERS AND GRILLES SCHEDULE

A. Fixed Face Grille :

1. Material: **Aluminum**.
2. Finish: **Baked enamel, color selected by Engineer**.
3. Mounting: **Countersunk screw**.
4. Damper Type: **Adjustable opposed blade**.
5. Accessories:

    a. **Front**-blade gang operator.
    b. Filter.

SECTION 235123
GENERATOR ENGINE EXHAUST SYSTEM

SECTION 235123
GENERATOR ENGINE EXHAUST SYSTEM

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Generator engine exhaust flue piping.
2. Seamless black steel exhaust pipes.
3. Thermal insulation for exhaust piping.
4. Aluminum cladding.
5. Exhaust muffler/silencer.
6. Flexible stainless-steel connectors.
7. Flexible stainless-steel elbows.
8. Spark arrestor.
9. Diesel Oxidation Catalyst (DOC) filtration unit.
10. Exhaust supports and hangers.
11. Roof penetration and flashing.
12. Rain cap/weather hood.
13. Accessories required for a complete operating system.

1.02 REFERENCES

A. ASTM International

- ASTM A105 – Carbon Steel Forged Flanges.
- ASTM A106 Grade B – Seamless Carbon Steel Pipe.
- ASTM A53 Grade B (where permitted).
- ASTM A234 WPB – Carbon Steel Butt – Welding Fittings

B. ASME

- ASME B31.1 – Power Piping.
- ASME B16.9 – Factory-Made Wrought Steel Butt-Welding Fittings.
- ASME B16.5 – Pipe Flanges.
- ASME B36.10M – Welded and seamless wrought steel pipe
  (Pipe dimensions and wall thickness, including schedule 40)

C. NFPA

- NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines.
- NFPA 110 – Emergency and Standby Power Systems.
- NFPA 30- Flammable and combustible liquids code
- NFPA 70- National electrical code (NEC)

D. ISO

- The generator manufacturer shall be certified to ISO:9001 Quality Management System

1.03 SUBMITTALS

a. Product Data.
b. Shop Drawings.
c. Manufacturer's Installation Instructions.
d. Exhaust pressure drop calculations.
e. Catalyst performance data (emissions reduction efficiency and pressure drop)
f. Muffler/ silencer performance data. (Noise attenuation/insertion loss and back pressure)
g. Acoustic performance data.
h. Insulation details.
i. Pipe supports and hangers details
j. Expansion joint / flexible connector details
k. Materials certificates for pipes, fittings, flanges, and insulations.
l. Welding procedure specifications (WPS) and welder qualifications.

1.04 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Exhaust Pipe

1. Tenaris
2. Vallourec
3. Nippon Steel
4. Jindal Steel
5. ArcelorMittal
   or approved equal.

B. Muffler / Silencer

1. Nelson Global
2. Donaldson
3. Dinex
4. Cummins
5. MANN + Hummel
   or approved equal.

C. Flexible Stainless-Steel Connectors

1. Senior Flexonics
2. BOA Group
3. EagleBurgmann
4. Metraflex
5. Hyspan precision products
   or approved equal.

D. Diesel Oxidation Catalyst (DOC)

1. Johnson Matthey
2. Eminox
3. Dinex
4. Cummins Emission Solutions
5. Donaldson
   or approved equal.

E. Insulation

1. ROCKWOOL
2. Owens Corning
3. Knauf Insulation
4. Saint-Gobain Isover
   or approved equal.

2.02 EXHAUST FLUE PIPING

Provide:

- **ASTM A106 Grade B** seamless carbon steel pipe.
- Schedule 40.
- Minimum wall thickness 4 mm.
- Butt welded joints.
- Heavy-duty supports.
- High-temperature resistant paint after fabrication.

2.03 EXHAUST PIPE INSULATION

Provide:

- 50 mm thick mineral wool / rock wool.
- Density 80–120 kg/m³.
- Service temperature minimum 650°C.
- Aluminum cladding 0.6–0.8 mm thick.
- Stainless steel bands at maximum 300 mm spacing.

2.04 MUFFLER / SILENCER

Provide heavy-duty industrial critical-grade exhaust silencer including:

- Acoustic insulation.
- Spark arrestor.
- Stainless steel flexible connector.
- Flanged connections.
- Suitable for continuous generator operation.
  Noise attenuation shall not be less than **30–35 dBA**, unless otherwise indicated.

2.05 FLEXIBLE CONNECTION

Provide stainless steel braided flexible exhaust connector complete with:

- Stainless steel bellows.
- Flanged ends.
- Vibration isolation.
- Minimum temperature rating 650°C.

2.06 FLEXIBLE STAINLESS-STEEL ELBOWS

Provide stainless steel exhaust elbows at generator outlet suitable for:

- Thermal expansion.
- Engine vibration.
- Continuous operation.

2.07 DIESEL OXIDATION CATALYST (DOC)

Provide factory-manufactured Diesel Oxidation Catalyst suitable for a **500 kVA** diesel generator.

The catalyst shall:

- Reduce Carbon Monoxide (CO).
- Reduce Hydrocarbons (HC).
- Reduce particulate matter.
- Be stainless steel construction.
- Have minimum 90% reduction efficiency for CO and HC under rated operating conditions.
- Be designed for exhaust temperatures up to 650°C.

2.08 EXHAUST TERMINATION

Provide:

- Exhaust discharge extending minimum **2 m above roof level**, or as required by local regulations.
- Rain cap/weather hood.
- Bird screen where permitted.
- Drain connection at lowest point.
- Flashing and weatherproof roof penetration.

PART 3 – EXECUTION

3.01 INSTALLATION

Install the complete exhaust system in accordance with the manufacturer's recommendations and NFPA 37.

3.02 SUPPORTS

Provide heavy-duty galvanized or painted steel supports designed to withstand thermal expansion and vibration.

3.03 INSULATION

Install insulation continuously over the complete exhaust piping system, including fittings and accessories.

3.04 TESTING

- Verify proper alignment.
- Check for exhaust leakage.
- Verify allowable engine back pressure.
- Measure vibration levels.
- Demonstrate satisfactory operation under full-load conditions.
- Submit commissioning and test reports.

SECTION 238126
DX SPLIT A/C SYSTEM

SECTION 238126
DX SPLIT A/C SYSTEM

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Split DX. cooling units complete in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following :
   1. Split DX. cooling units.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories; and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring for split DX. cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field installed.

1.03 QUALITY ASSURANCE

A. Manufacturers Qualifications : Firms regularly engaged in manufacturer of Air Filters units of types and capacities required whose products have been in satisfactory use in similar service for not less than 5 years.

B. Regulatory Requirements:
   1. ASHRAE Compliance: Construct refrigeration system of split DX. cooling units in accordance with ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration".
   2. UL Compliance: Provide split DX. cooling units which are designed, manufactured, and tested in accordance with UL requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle split DX. cooling units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged split DX. cooling units or components; replace with new.

B. Store split DX. cooling units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading split DX. cooling units, and moving them to final location.

1.05 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A. Split DX. Coolings Units :
   1. Carrier, U.S.A.
   2. Daikin, Japan
   3. Hitachi, Japan
   4. Trane Co., France, Malaysia
   5. York, U.S.A., Malaysia
   6. Mitsubishi, Japan
   7. Gree
      Or approved equal

B. The products or manufacturers listed herein are included for the purpose of establishing minimum quality standards. Products equal in quality or better than those specified will be considered if they are produced by a specialized manufacturer whose units are equal in every respect and have been in similar service for not less than five (5) years. The decision of acceptability shall rest with the Engineer.

2.02 MATERIALS

A. Split D/X Units
   1. General: Provide factory-assembled and tested split DX. units as indicated, designed for roof, slab or floor mounting, consisting of compressors, condensers, evaporator coils, refrigerant piping, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers. Provide capacities and electrical characteristics as scheduled.
   2. Casing: Provide manufacturer's standard casing construction, corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts.
      Insulate casing with 1" thick minimum thermal insulation. Provide knockouts for electrical and piping connections. Provide condensate drain connection, and lifting lugs.
   3. Evaporator Fans: Provide forward-curved, centrifugal, belt-driven fans with adjustable sheaves and permanently lubricated motor bearings.
   4. Condenser Fans: Provide propeller-type, direct-driven fans with permanently lubricated bearings.
   5. Coils: For evaporator and condenser, provide non-ferrous construction with aluminum plate fins mechanically bonded to seamless copper tubes; with brazed tubing joints. Circuit evaporator to provide full active face on minimum cooling step. For condenser provide 25% extra surface area. Aluminum fins shall be with corrosion protection coated.
   6. Compressors: Provide serviceable, semi-hermetic, or hermetic compressors. Provide vibration isolators, and crankcase heaters which de-energize during compressor operation.
      a. Provide cylinder un-loaders for capacity control, with minimum steps as scheduled.

b. Provide thermal expansion valves, filter dryers, sight glasses, compressor service valves, liquid line service valves; and provide minimum of 2 refrigerant circuits for units having 2 or more compressors. Provide fan- cycling control for low ambient control to 45°F (7°C).

7. Safety Controls: Provide the following controls:
   a. Low pressure cutout, manual reset.
   b. High pressure cutout, manual reset.
   c. Compressor motor overload protection, manual reset.
   d. Anti-recycling timing device.
   e. Adjustable low-ambient lockout.
8. Refrigerant Piping and Fittings
   a. Refrigerant pipes installed in the field shall consist of copper tubing and recessed solder joint fittings. Tubing shall be in accordance with ASTM Specification B 88-61 type 'K' hard drawn. Fittings shall be wrought copper or tinned cast brass. Where required for connection to gauges and control devices, tubing not larger than 3/8 inch. O.D. may be type 'K' soft (annealed) with flared tube or double ferrule compression fittings suitable for high pressure. On all joints in refrigeration piping flux and solder which is recommended by solder type fittings manufacturer shall be used. Tubing shall be protected against oxidation during silver soldering by use of dry nitrogen flowing through the tubing.
   b. Refrigerant stop valves shall be of the back seating, key operated seal cap type. Valves which must be opened and closed in regular operation shall have hand wheels and shall be of the backless type. Valves connected to copper tubing shall have solder type ends or flanged ends and soldered flange adapters.
   c. Accessories for field assembled refrigerant piping systems such as oil separators, liquid receivers, heat exchangers, driers, expansion valves, refrigerant strainers, sight glass etc., shall be in accordance with instructions of the units manufacturers standard practice and specific recommendations.
   d. Drain line shall be of copper pipe type "L" fitted with dielectric fitting to drain pan.
   e. Refrigerant pipes shall be thermally insulated with moulded factory shape sectional pipe covering closed cell elastomeric foam rubber insulation with density 65-80 kg/m3 having a thermal conductivity factor of 0.037 W/m.k at 20 deg. C and 0.040 W/m. K at 40 deg. C.

      1. Insulation thickness shall not be less than 25 mm.
      2. Insulate and finish valves and fittings in the same manner and same thickness as piping in which such items are installed.
      3. External refrigerant pipe insulation shall be covered with 20 x 20 woven glass cloth cover. The cloth cover shall be protected and coated with two coats of waterproof sealant.

9. Filters: Provide filter section consisting of 2" thick fiberglass throwaway filters in filter rack, with maximum face velocity of 300 fpm.

B. Automatic Temperature Control System: Provide combination thermostat and fan switches to control the room temperature automatically, Provide factory fabricated unit of the same manufacturer of DX-Split unit having sensor, 4-

position push button or lever operated manual switch for control of fan compressor interlock and control transformer as an integral part of the unit.

C. Electrical: Provide 240 V convenience outlet, separately fused, for unit service. Provide means for unit power connection through unit cabinet.

D. Accessories:
   1. Anti-Recycling Control : Provide controls to automatically prevent compressor restart for 5-minutes after shutdown.
   2. Time Guard: Provide time guards to prevent short cycling of compressors.

2.03 SOURCE QUALITY CONTROL

A. Test and rate split DX. cooling units of 135,000 btu/hr capacity or over in accordance with ARI 360 “Standard for Commercial and Industrial Unitary Air-Conditioning Equipment”.

B. Test and rate split DX. cooling units under 135,000 btu/hr capacity in accordance with ARI 210 “Standard for Commercial and Industrial Unitery Air-Conditioning Equipment”, and provide Certified Rating. Sound test and rate units in accordance with ARI 270 “Standard for Sound Rating of Outdoor Unitary Equipment”, and provide Certified Rating.

Part 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which split D/X cooling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SPLIT DX. COOLING UNITS & MINI SPLIT

A. General: Install split DX. cooling units and mini split units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in approved locations, and maintain manufacturer's recommended clearances.

B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal.

3.03 START-UP

A. Start-up split DX. cooling units, mini split units and room air-conditioners in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Balance split DX. unit systems to verify its capacity and balanced delivery of air for each space.

3.04 GROUNDING

A. Provide Positive equipment ground for split DX. cooling unit, mini split units and room air- conditioners components.

LEBANESE REPUBLIC
GENERAL DIRECTORATE OF THE PRESIDENCY
PRESIDENTIAL PALACE COMPOUND- BAABDA

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

TENDER DOCUMENTS

VOLUME 2

TECHNICAL SPECIFICATIONS

ELECTRICAL ENGINEERING SERVICES -R1

L2026-14/2026

Prepared by

October - 2026

SPECTRUM ENGINEERING CONSULTANTS S.A.R.L.
ISO 9001:2000

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

VOLUME 2 : TECHNICAL SPECIFICATION

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Division 26 - Electrical

SECTION 260500
COMMON WORKS RESULTS FOR ELECTRICAL

SECTION 269500
COMMON WORKS RESULTS FOR ELECTRICAL

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic electrical materials and methods requirements. The work of this section is integral with the whole of the contract documents and is not intended to be interpreted outside that context.

Part 2 - PRODUCTS

2.01 MATERIALS

A. All equipment and materials used in the electrical installation work shall be new and of the highest quality to the best modern practices. All materials shall be approved types, supplied by approved manufacturers and shall be fully suitable for use in the climatic conditions stated and on standard frequency and voltage of Lebanon.

B. All electrical materials and equipment shall comply in all respects (design, properties, qualities, testing, etc.) as a minimum with the latest International Electro technical Commission (I.E.C.) recommendations (as applicable), EDL, and Civil Defense Regulations.

C. Should there be any difference between the IEC/BS and this Specification, then the specific requirements of this Specification shall prevail.

D. All materials brought to site for use on the project shall be offered for inspection by the Engineer. The Engineer reserves the right to inspect materials on site at reasonable times and to reject any materials not complying with the specifications.

E. The cost of dismantling and re-erection of the installation occasioned by the removal of the rejected materials shall be at the Contractor's expense.

F. Component parts of similar use and rating shall be interchangeable with each other.

G. All manufactured items shall be the product of manufacturers regularly engaged in producing works of the types specified and be constructed and finished by the same manufacturer.

H. All manufactured items shall be free from imperfections and defects which affect their appearance or may impair their durability or serviceability.

2.02 ORDERING OF MATERIALS

A. The detail of equipment and materials shall include the following:
   1. Full Technical Specifications of equipment including construction, materials, degree of protection, characteristics, curves, diagrams, ratings, dimensions, fixing details, etc.
   2. Relevant sheets of manufacturer's catalogues, specifications, technical data, etc.
   3. Confirmation that equipment and materials offered complies fully with relevant clauses of the Specification and, in case of deviation from the Specification, a schedule of deviations listing all points not conforming to the Specification shall be submitted for the Engineer's approval.
   4. Short circuit study including all components shown on the Schematic Diagrams.

B. Submit at the request of the Engineer, a sample of any equipment or material for further study before approval.

C. Manufacturers specified by name are not relieved of the responsibility for compliance with the Specification.

Part 3 - EXECUTION

3.01 FIXING

A. General
   1. Unless indicated elsewhere in the Specification or on the drawings, the Contractor shall provide and make all fixings to the building for all services included in this Contract.

B. Raw bolt or similar approval fixings shall be used for heavy loads. Plastic or fiber plugs shall be used for light loads. Other proprietary methods may be specified later in this Specification. The Contractor may offer alternative methods to those specified but the Engineer reserves the right to reject such alternative and call for the use of the specified methods only.

C. All metal fixing devices shall be zinc or cadmium plated, sheradized or hot dipped galvanized including any expansion shields, plugs, nuts, washers, etc., associated with the fixing devices.

D. The Contractor shall carry out any drilling and plumbing for screw fixings of pipe work, raceways, cable trunking, ducting, wiring, conduit fittings, accessories and finishing trims supplied under this Contract.

E. Generally equipment and supports shall be fastened to:
   1. Solid masonry or plastered surfaces by suitable anchors and screws and bolts.
   2. Poured concrete by expandable inserts.
   3. Hollow masonry walls or suspended ceilings by patent retention type fastenings. The Contractor shall establish that there is adequate strength in such hollow material before fixing same.

F. Supports or equipment installed by other trades shall not be used.

G. Purpose made fixing clips and brackets may be necessary in certain areas and the Contractor shall be deemed to be aware of this at the time of tendering and to have included for the supply and fixing of same in this Tender Bid.

H. Details of proposed clips and/or brackets shall be submitted to the Engineer for approval, prior to the manufacture of same being commenced.

I. Holes shall not be drilled in any structural steel work or prestressed concrete without first obtaining the approval of the Engineer.

J. Where it is proposed to use cartridge fired bolts for fixing to blockwork or concrete, approval shall first be obtained from the Engineer. The ruling also applies to stud welded fixing on steel structures.

K. All supports or mountings described above, shall be steel, hot dipped galvanized after fabrication wherever practicable. In cases where the Engineer agrees that it is not practical to provide galvanized steel, supports and mountings shall have at least two coats of rust resistant paint applied.

L. No conduit or boxes shall be embedded in structural columns without the prior approval of the structural engineer at site.

M. Electrical and telephone manholes dimensions shall be according to local authorities detail drawings. Installation details for covers shall be according to landscape drawing details.

SECTION 260510
BASIC ELECTRICAL REQUIREMENTS

SECTION 260510
BASIC ELECTRICAL REQUIREMENTS

1 - GENERAL

1.1. RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other chapters of part 3.

1.2. SCOPE OF WORK

1.2.1 The scope of electrical work for the Project will include but is not necessarily limited to:

A. Power Supply and Distribution consisting of:
- co-ordination with Electrical Authority for power supply
- main distribution boards,
- distribution, sub-distribution and final branch circuit panelboards,
- cables, wires and related accessories,
- conduits, wireways, supporting systems and related accessories,
- Earthing system.
- 1600 kva oil type transformer
- MV. switchgear

B. Standby Emergency Power Distribution capable of catering to 100 per cent of the total load and 50% standby, consisting of:
- 3 Diesel engine driven generators,
- Load-sharing panelboard housing the electrically operated contactors (automatic transfer switches), load-sharing controls – modules and load management system,
- Automatic transfer switches some of which, with bypass capabilities.
- Totalizing & synchronizing generators panel

C. Lighting and Power Installations including:
- Functional indoor and outdoor lighting installations,
- Wiring devices including all lighting switches, isolating switches, socket - outlets, plates,
- Emergency battery operated lighting.

D. Life safety and low current systems consisting of:
- Fire detection and alarm system,

1.2.2. Unless otherwise specified, includes the supply, installation, testing and commissioning of the complete electrical systems, equipment and materials shown on the Drawings and/or described in the Specification together with all associated ancillary work, support work and builder's work in connection.

1.2.3. Incoming power supply and connection will be provided by the Local Power Authority at 220/380 V to the location shown on the Drawings.

1.2.4. Telephone public exchange lines will be brought into the premises by the Local Telephone Authority to the location shown on the Drawings and/or to be agreed with the Authority.

1.3. GENERAL REQUIREMENTS

1.3.1. INSTALLATIONS GENERALLY:

A. Carry out electrical work in accordance with the Drawings, Specification and Regulations, ensuring compliance with design and performance requirements, to provide safe and protected systems with equipment readily accessible for operation, maintenance and repair

B. Installations are to be complete, ready for operation and fully integrated and coordinated with all other work

C. Installations are to be carried out by qualified personnel

D. Provide accessories necessary to complete the installations, of the types specified or recommended for the purpose by the manufacturer of the equipment or accessories.

E. Disconnect the cables from the existing panels and reinstall them on the new panels.

F. Taking care not to cut off the power completely; disconnecting and reconnecting each panel stage by stage; in coordination with the technical team in the palace.

1.3.2 EQUIPMENT SPACES AND ROOMS: check that dimensions, structure, ventilating and cooling arrangements and other provisions in equipment spaces and rooms are suitable for installation, operation and maintenance of proposed equipment. Note any discrepancies on the shop and construction drawings. The Contractor is responsible of planning the erection of the electrical equipment such that it is not interfering with any other trade in the building.

1.3.3. POWER SUPPLY: liaise with the Local Power Authority to confirm:

- Characteristics of supply and system earthing
- Location of incoming supply shown on the Drawings
- Space requirements and associated builder's work for the Authority's installations.
- Make necessary arrangements at the earliest opportunity to ensure connection as and when required, and inform the Engineer in the event of any foreseen delay.

1.3.4. Systems used before substantial completion for the benefit of the Contractor are to have all consumable elements, such as lamps etc. and defective equipment replaced by new, within 7 days prior to the date of substantial completion.

1.3.5. Dismantling for the existing old transformer cables & electrical panels after full coordination with EDL & the technical team in the palace.

1.4. DESIGN CONDITIONS

1.4.1. Nominal characteristics of power supply and distribution are as follows:

A. low voltage : 380 V, 3 phase, 4 wire, solidly earthed neutral

B. frequency : 50 Hz.

1.4.2. DISTRIBUTION SYSTEMS are to be supplied or derived from the voltage system previously described, as shown on the Drawings, or as otherwise specified.

1.4.3. EQUIPMENT is to be designed for the system voltage and frequency previously described, unless otherwise specified. Special provisions are to be made for equipment sensitive to power supply frequency and voltage variations and for equipment operated at other voltages/frequencies or by direct current sources.

1.4.4. KWH-METERING will be as per the existing.

1.4.5. CLIMATIC CONDITIONS: equipment, including transformers, switchgear, cables, relays, lighting fixtures, motors etc., is to be designed and derated for continuous and trouble-free service under the following climatic conditions:

A. altitude : 200m from sea level

B. maximum ambient temperature: 40 deg. C (in the shade)

C. minimum ambient temperature: 4 deg. C

D. maximum relative humidity: 90 %

E. atmospheric conditions: 1 bar

Where design and operating conditions, different from the above are required for particular equipment, they are described in the specification of the equipment concerned.

1.4.6. REGULATIONS: carry out electrical work in accordance with the current issue of the local codes and practice, local power authority regulations and IEC Regulations for Electrical Installations, where not in contradiction with the local codes and practice and regulations, herein referred to collectively as 'the Regulations'.

1.4.7. CONFLICT should an instance occur in this specification or on the drawings in which material or construction methods called for are less than minimum requirement of the Regulations, the Engineer shall be immediately informed

in writing. Consequent to Engineers approval, supply the materials and perform the work as through called for to minimum code standards.

1.4.8. REFERENCES STANDARDS: unless otherwise specified, equipment and materials are to be manufactured and installed in compliance with the relevant recommendations of the following:

IEC : The International Electro-technical Commission
ISO : The International Standardization Organization
EN : European Norm
NF-USE : The French Regulation
BS : The British regulation
IEEE : Institute of Electrical and Electronics Engineers, Inc.

1.4.9 The minimum standards for products specified in this section shall be latest relevant IEC standards (as applicable) including but not limited to the following. Except as otherwise specified herein, perform work in accordance with specification codes and standards cited therein and to latest applicable addenda and supplements.

1. Relevant IEC Standards.
2. Regulations issued by EDL.
3. Lebanon Civil Defense requirements.
4. Other Local Authority/Baadba Municipality
5. The requirements of the specifications are based on the conformance with B.S or US. Codes and standards:

5-1 Low voltage electrical insulation; protection against voltage disturbances EEC-60364-44:

- Circuit breakers for overcurrent protection, circuit breakers for A.C and D.C operation IEC 60898-2
- Low voltage switchgear & control gear- circuit breakers. IEC 60947-2-
- Low voltage switchgear and control gear assemblies IEC 61439

5.2 Standards test methods:
ASTM E-(1036; 1171; 1799; 1802; 1830 and 2047)

5.3 The cable installation shall comply with EDL regulations or the following International Standards (as applicable):

- Specification for Pressure-Sensitive Adhesive Tapes for Electrical Insulating Purposes (BS 3924)
- Specification for Armoured Cables with Thermosetting + IEC 502 Insulation for Electricity Supply (BS 5467)
- Specification for XLPE Cables (BS 5468)
- Specification for PVC-Insulated Cables (non-armoured) for + IEC 227 Electric Power and Lighting (BS 6004)
- Specification for Mechanical Cable for Elastomer and Plastics Insulated Cables (BS 6121)
- Specification for PVC-Insulated Cables for Electricity Supply (BS 6346)
- Specification for High Conductivity Plain Annealed Stranded

Copper Conductor (BS 6360)
- Requirements for Electrical Installations (BS 7671)
- Code of Practice for Selection, Installation and Inspection of Cable Glands used in Electrical Installations (BS 6121)

5.4 The installation for low voltage switchgear and switch boards shall comply with the following Standards, including all amendments:
- Switchgear & Control Gear Assemblies-General rules (IEC 61439-1 LV)
- LV Switchgear & Control Gear Assemblies - Power Switchgear and Control gear Assemblies (IEC 61439-2)
- Enclosed LV Switchgear & Control Gear Assemblies Guide for testing under conditions of arcing due to internal fault (IEC 61641)
- LV Switchgear & Control Gear - General rules (IEC 60947-1)
- Circuit breakers (IEC 60947-2)
- Specification for Cartridge Fuses for voltage up to and (Part 1 to 4), including 1000V A.C. and 1500V D.C. BS 88 (IEC 60269)
- Direct Acting Indicating Analog Electrical (1 to 9 parts) Measuring Instrument & their accessories (IEC 60051)
- Environmental Testing (IEC 60068).

5.5 Or other equal and approved standards, herein reffered to as the standards. Local standards, where enforced and relevant, are to have precedence over the standards.

1.5. THE DRAWINGS

1.5.1 EQUIPMENT LOCATIONS shown on the Drawings indicate the approximate locations and general layout of equipment. Exact and final locations and layouts together with dimensions, weights, mounting methods and accessories, where relevant are to be shown on the shop and construction drawings. All protecting device shall show: the short circuit current value for single and three phase current, the voltage drop, the indirect protection function in case of a fault with respect the earthing system.

1.5.2. WIRING LAYOUTS shown on the Drawings are to be used as a guide only to defining basic positions, circuiting, loading and switching arrangements. Actual layouts and details of routing of circuits are to be shown on the shop and construction drawings.

1.5.3. WIRING LAYOUTS shown on the Drawings for work not included in the Electrical Work are shown for convenience and reference only.

1.5.4. SYMBOLS: in order to provide sufficient detail and a minimum degree of clarity on the drawings, the symbols used for the various electrical devices, particularly wall mounted devices, take up more space on the drawings than the device does on the wall. Because of drafting limitations these locations must be considered as being symbolic rather than exact physical locations of the devices.

1.5.5 The devices shall be installed with prime regard for convenience of operation and the best usage of the wall space for this and other purposes rather than string the devices out along the wall so as to coincide with the scaled locations of the symbols. In locating the outlets, follow the criteria provided on detail drawings where provided, and co-ordinate with furniture. Submittal of detail drawings is required for this purpose before execution. Do not scale from design drawings.

1.6. EQUIPMENT AND MATERIALS

1.6.1. AVAILABILITY: confirm availability of equipment and materials proposed for use in the work prior to submission for approval. If, after approval, equipment or materials cease to be available, submit alternative items of equal quality and type for approval.

1.6.2. ACCEPTANCE BY AUTHORITY: confirm that proposed equipment and material characteristics where required are compatible with the requirements of the Local Power Authority or other authorities having jurisdiction and are acceptable to them. Inform the Engineer of any modifications necessary to comply with the Local Power Authority's requirements.

1.6.3. MANUFACTURERS' STANDARDS: equipment is to be the latest standard product of the manufacturer. Component parts are to be the product of a single manufacturer, unless otherwise approved and provided that components made by other manufacturers are of a standard design and are interchangeable.

1.6.4. APPROVED MANUFACTURERS: listing of approved manufacturers in the Specification does not necessarily constitute approval of their standard products as equal to those specified. As certain that listed manufacturers are able to supply equipment and material in conformity with the Specification.

1.6.5. FACTORY ASSEMBLY: equipment generally is to be supplied in complete factory assembled units ready for installation on site. Dis-assembly necessary for transportation or other purposes is to be arranged to limit site work to simple re- assembly and inter-wiring of control and power cabling.

1.6.6. STORAGE OF MATERIALS: equipment and materials are to be stored in an approved location, under cover, free from humidity, dust, debris and rodents. Equipment sensitive to heat and humidity is to be kept in climatically conditioned areas until installed and handed over.

1.6.7. DEFECTIVE EQUIPMENT: the Employer reserves the right to operate operable defective equipment during the Defects Liability Period until it can be removed from service for repair or replacement.

1.6.8. WARRANTY: where required by the Specification, provide a warranty, signed by the manufacturer (including his agreement to replace promptly, defective equipment or parts thereof, as instructed by the Engineer) covering materials and workmanship for the period stated in the Specification, starting on the date of duly recorded provisional acceptance of

the completed, tested and accepted equipment under the contract. The Contractor is to assign the benefits of such warranty to the Employer.

1.6.9. SPARE PARTS: not later than the date of substantial completion, provide spare parts required by the Specification, together with suitable means of identifying, storing and securing same.

1.6.10. TOOLS AND INSTRUMENTS: not later than the date of substantial completion, provide sets of tools and instruments required by the Specification, together with suitable means of identifying, storing and securing same.

1.6.11. LABEL AND IDENTIFY all equipment, instruments, control and electrical devices etc. to indicate duty, service or function, to the satisfaction of the Engineer. Labels are to be laminated plastic or anodised aluminium discs with black surface and white core with incised lettering in English or Arabic to the satisfaction of the Engineer. Alternative methods of labelling may be submitted for approval. Fix labels with non-corrodible screws to equipment, or to adjacent permanent surfaces or as approved by the Engineer.

1.6.12. EQUIPMENT NAMEPLATES are to be non-corroding, robust metal, inscribed in English, and firmly fixed to equipment at factory. Nameplates are to indicate name and address of manufacturer, model, serial number, basic characteristics and ratings of equipment and are to include elementary diagrams etc., all in accordance with the Standards.

1.6.13. FIREPROOFING: Where cables, cable trays, busducts or conduits pass through floors and fire rated walls, pack space between wiring and sleeve full with materials and seal with approved caulking compound.

1.7. SUBMISSIONS

1.7.1. GENERALLY: submit for approval, manufacturers' technical literature, shop and construction drawings and other information required by the Specification, before ordering equipment or materials and before executing any related work on site.

1.7.2. TECHNICAL LITERATURE is to include detailed manufacturers' specifications and original catalogues or catalogue cuts, characteristics, model number, application and operating criteria of all equipment and materials, together with other information necessary to satisfy the Engineer that proposed equipment and systems are suitable and adequate.

1.7.3. SHOP AND CONSTRUCTION DRAWINGS are to demonstrate to the Engineer that the design requirements are understood by indicating all equipment and material proposed to be supplied and installed and by detailing fabrication and installation methods proposed to be used. Shop and construction drawings are to clearly state the name and location of the work, the names of the Engineer and Contractor, submission date, cross-references to the Drawings and Specification and the specific reference number, location, service and function of each item.

1.7.4. LIST OF PROPOSED MANUFACTURERS of all equipment and materials, including all items for which choice of manufacturer is at the discretion of the Contractor, is to be submitted for approval.

1.7.5. TEST CERTIFICATES AND REPORTS: where required by the Specification, submit manufacturer's type and routine test certificates and reports for equipment and devices. Complete test results are to be submitted in clearly identified and organized booklets, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures.

1.7.6. LABORATORY TESTS: if manufacturer's test certificates are considered unsatisfactory, then independent laboratory tests are to be carried out on equipment in accordance with the Specification and the Standards, as required by the Engineer.

1.7.7. SPARE PARTS SCHEDULES: submit with the Tender itemised schedules of spare parts to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.

1.7.8. TOOLS AND INSTRUMENTS SCHEDULES: submit with the Tender itemized schedules of tools and instruments to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.

1.7.9. LABELLING SCHEDULE: submit for approval, prior to installation, a schedule of all equipment and devices to be labeled and the suggested details, lettering, position and fixing methods of each label indicating its application.

1.7.10 SAMPLES: submit samples of all equipment and materials for approval. Major items of equipment for which samples cannot be submitted are to be demonstrated in existing installations or by manufacturer's information, test certificates and reports.

2 - SPECIAL REQUIREMENTS FOR ELECTRONIC EQUIPMENT

2.1. REQUIREMENTS

2.1.1. CONSTRUCTION: electronic components of communication systems, security systems and special systems and electronic components forming part of the power generation and distribution system are to be solid-state integrated construction, unless otherwise approved.

2.1.2 TEMPERATURE LIMITS: manufacturer is to indicate maximum and minimum ambient temperatures acceptable for the equipment to operate continuously and normally and beyond which electronic components may suffer permanent damage.

2.1.3. ALTERNATIVE ELECTRONIC EQUIPMENT may be submitted for approval,

provided such equipment meets or exceeds the functional capabilities and/or performance parameters of the equipment specified. Proposals for alternative equipment will be considered only if accompanied by the following information:

A. list of operational characteristics and performance parameters

B. list of differences in operation and performance between proposed and specified equipment

C. list of changes required and resulting implications

D. drawings indicating changes required to system wiring

E. statement of advantages of proposed equipment over that specified.

2.1.4. PROTECTION: solid state equipment under normal conditions of operation is to withstand any surges which might be produced by sudden mains or standby power switching operations. Protective devices are to be provided to protect against surges, failure of output stages due to open circuit, short-circuit or impedance mismatch. In the absence of IEC standards comply with IEEE standard 472 (ANSI/IEEE C37.90 "Guide for Surge Withstand Capability Tests". System/equipment which may be adversely affected by short duration power blackouts shall be capable of riding through such a disturbance by having an internal battery back-up to the memory / microprocessor, etc.

2.1.5. INDICATOR LIGHTS shall be Light Emitting Diodes (LEDs).

2.1.6. ELECTROMAGNETIC RELAYS and control/small power transformers are to be designed to withstand the 500 V a.c. test voltage between winding and winding or winding and core.

2.1.7. DUST COVERS, easily removable for inspection and servicing, are to be provided for all relays and sensitive elements.

2.1.8. SEGREGATION OF WIRING: design wiring so that low current circuits are segregated from power wiring, using different conduits and wireways for the purpose. Composite wiring is acceptable for the same system in accordance with the relevant codes. Cable insulation is to be same grade for all conductors in a common enclosure.

2.1.9. POWER SUPPLY UNITS for low current systems which are fed from the LV supply are to be independently fused on the live conductor and are to have front panel mains indicator light, on/off switch and standard cartridge type fuse holder. Blown fuse indicator lamp is to be provided when fuse does not have an indicator.

3 - TESTS ON SITE, RECORDS, TRAINING AND MAINTENANCE

3.1. TESTS ON SITE

3.1.1. GENERALLY: carry out inspection and acceptance tests on site on each complete system, before final placement into service, in accordance with the Regulations and Standards, as described in the Specification and required by the Engineer.

3.1.2. TEST SCHEDULES AND PROCEDURES are to be submitted for approval and are to include details of testing equipment to be provided.

3.1.3. WITNESSING: inspection and acceptance tests are to be carried out in the presence of the Engineer and, when required, by an authorized representative of the Local Power Authority.

3.1.4. VISUAL INSPECTION: visually check proper installation, connections and nameplate data before testing.

3.1.5. INSULATION RESISTANCE: test the feeders, lighting and power circuits, motors and other power equipment of low voltage installations with a megger of not less than 500 V d.c. for installations rated up to 500 V (r.m.s. value of a.c. supply) and 1000 V d.c. for installations rated above 500 V up to 1000 V, and as required by the particular Section of the Specification.

3.1.6. INSULATION RESISTANCE: unless otherwise specified or approved, test the circuit insulation resistance related to communications and security systems with a megger of not less than 500 V operating voltage, with equipment disconnected.

3.1.7. CONTINUITY: test all feeders and circuits for continuity.

3.1.8. OPERATIONAL TESTS: carry out operational tests on all equipment and complete systems to verify proper performance in compliance with the Specification. Tests are to be carried out under normal operating conditions for not less than 3 days, and as required by the Engineer.

3.1.9. SPECIFIC TESTS: carry out specific tests required by the Specification and any other tests required by the Engineer to verify compliance of the installations with the Specification.

3.1.10. LOAD BALANCE: upon completion of the building and immediately prior to final inspection and take-over, check load balance on all feeders and at distribution centers, panels, etc. Conduct tests by turning on all possible loads in the building and checking the load current balance. If load unbalance exceeds 15%, rearrange and reconnect circuits to balance the load after Engineer's approval.

3.1.11. VOLTAGE CHECKS: perform voltage checks throughout the building and if directed by the Engineer, adjust the transformer tap settings where a

transformer is provided on the supply end, or report to power authority for adjustment necessary.

3.1.12. CURRENT CHECKS: In cooperation with the mechanical sub-contractor, take clip-on ammeter readings on all phases of all mechanical equipment motors with motors operating under full load conditions. Test readings shall be submitted to the Consultant.

3.2. RECORDS

3.2.1. GENERALLY: not later than the date of substantial completion, provide the Engineer with four copies of all approved as-installed drawings, test records, manufacturers' guarantees and warranties, operating and maintenance manuals and other records required by the Specification.

3.2.2. PRESENTATION OF RECORDS is to be in A4 size plastic covered, loose-leaf ring binders or other approved binders with hard covers, each indexed, divided and appropriately cover titled. Drawings larger than A4 size are to be folded in the binders so that they may be unfolded without being detached.

3.2.3. AS-INSTALLED DRAWINGS are to contain the complete assembled information included on the construction drawings, prepared in the same manner, and up-dated to indicate the systems, labeling, referencing, mounting methods, routing etc. as installed. Submit complete drawings for approval. Provide the Engineer with one set of transparencies in addition to the four copies required.

3.2.4. TEST RECORDS are to include test certificates of type tests, routine tests, site tests, commissioning and performance tests and all other tests on equipment and installations described in the Specification and required by the Engineer. Information is to include test procedures and results, conditions under which tests were carried out including set points, temperatures and the like, dates, location and attendance by authorized representatives etc.

3.2.5. OPERATING AND MAINTENANCE MANUALS are to contain the following:

A. Technical description of each system and item of equipment installed, written to ensure that the Employer's staff fully understand the scope and facilities provided.

B. Diagrammatic drawings of each system indicating principle components and items of equipment.

C. Schedules (system by system) of equipment installed giving manufacturer, catalogue list numbers, model, rating, capacity and operating characteristics; each item is to have a unique code and number, cross- referenced to the diagrammatic drawings and layout drawings.

D. Name, address, telephone and e-mail address of the manufacturer of every item of equipment.

E Name, address, telephone and e-mail address of equipment agents/representatives for emergency services and procedures.

F. Manufacturer's service manual for each major item of equipment, assembled specifically for the project, including detailed drawings, illustrations, circuit details, operating and maintenance instructions, modes of operation, control provisions, sequences and interlocks and preventative maintenance program.

G. Schedules of all fixed and variable equipment settings established during commissioning.

H. Procedures for fault finding, where applicable.

I. Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items which may involve extended deliveries.

3.2.6. OPERATING AND MAINTENANCE MANUALS: prepare two temporary copies with provisional record drawings and preliminary performance data and make available at time of testing and commencement of commissioning to enable the Employer's staff to familiarize themselves with the installations. Temporary copies are to be in the same format as the final manuals with temporary insertions for items which cannot be finalized until installations are commissioned and performance tested.

3.3. TRAINING

3.3.1. OPERATION AND MAINTENANCE TRAINING: before the date of substantial completion, explain and demonstrate to the Employer's maintenance staff the purpose, function and operation of the installations including all items and procedures listed in the operating and maintenance manuals. Include for not less than thirty days for this purpose.

3.4. MAINTENANCE

3.4.1. MAINTENANCE CONTRACTS: where required by the Specification, submit supplementary proposals for annual maintenance contracts. The proposals are to:

A. include for maintaining the installations in efficient working order including routine and emergency service checks, adjustments, lubrication and the supply and replacement of damaged parts etc.

B. set out the terms of the offer, the work to be carried out, the guarantees of performance and the price of the work or part thereof for the first twelve months after substantial completion.

SECTION 260514
BUILDING MANAGEMENT SYSTEM (BMS)

SECTION 260514
BUILDING MANAGEMENT SYSTEM (BMS)

PART 1 - GENERAL

1.1 Definition

A Bulding Management System (BMS) is a centralized Software and Hardware platform that monitors and controls a bulding mechanical, electrical, and plumbing (MEP) systems. These automation systems improve efficiency, confort, and safty by managing equipment such as HVAC, lighting, power, fire systems security and electrical systems.
Centrally, a BMS connects and controls critical bulding systems, including power systems as a key component, using a combination of field devices, controllers, communication protocols (BACnet or Modbus), and user interfaces.

1.2 Related Documents

Drawings and general provisions of Contract, including General and Particular Conditions and Specification Sections, apply to this Section.

1.3 Work Includes

A fully integrated Building Management System (BMS), UL listed, incorporating Field Processing Unit (FPU) or (DDC) Direct Digital Control technology, equipment monitoring (LED SCREEN) and control including colour graphic workstations. System major elements include, without being limited to, the following:

- Computer based processing units.
- Personal computer operator workstations with
- LED screen.
- Data storage units.
- Stand alone Data terminal units.
- Data communication units.
- Portable operator’s terminals.
- Data interface units.
- Communication cable.
- System software.

1.4 Related Work

The Mechanical & Electrical works contain requirements that relate to this section:

1.5 Scope of Work

General: all materials and/or equipment, necessary for proper operation or monitored of the systems, not specified or described herein are to be deemed part of the Specification. Perform the work under this section and provide all labour, materials, services, equipment and accessories necessary to furnish and install all instrumentation and equipment as indicated by the BMS schematic drawing and/or as required by the Specification, which without limiting the generality thereof, consists of the following:

a) Master Control Station:
- To be located in the control room and to be the operator's position for the systems being monitored and controlled. From this position the operator is to monitor and or control all systems of the building (fans, switch-gear units, sub-stations, new and existing generators and related Totalizing panel, existing generator,Totalizing pael concerning solar / EDL or generators, ATS'S, MDB-1, MDB-2 and all new distribution panels RES-1, RES-2 RES-3 RES-4, and chiller panel etc..) the operator is to monitor and or control all future equipment related to HVAC system and related pumps or other systems to be monitored or controlled within the palace via a communication network.
- The Master Control Station must be interfaced with the solar system in order to monitor the status for all solar equipment (inverters and related totalizing panel, step up and step down transformers and related MV switchgears, PCS and Battery Energy Storage System (BESS) etc…
- The Master Control Station must be interfaced with the fire Alarm Control Panel FACP in order to monitor the status for this FACP and must monitor the status for the system and the supprision panels related to FM200.

b) Field Processing Unit (FPU) or Direct Digital Control (DDC):
to monitor and control all functions specified on the function list. DDC's or FPU's are to be of the pre-programmed and/or programmable type of appropriate number of input/output points for the specified application.

c) Interfacing Panels to enable connection to physical control points via transducers, signal conditions, interposing relays and the like.

d) Instrumentation, including sensors/transducers, transformers, sensing piping, tubing as required.

e) Field wiring conducting communication trunks from DDC / FPU back to central processors in addition to interconnections between processors peripherals, etc. to yield a complete system. This to include power supply connection from nearest panel va appropriate UPS

f) Shop drawings, as-built drawings, instruction manuals, source code programme listing and all other documentation as required.

g) Testing and commissioning of installations to take over.

1.6 System Description

1.6.1. Building Manegement System (BMS): Distributed process control system consisting of central control, central communications, and remote-control systems to monitor and or control the following building systems:

- Emergency power generators and the related main fuel tank thru BACnet Interface to be supplied by Fire Alarm supplier.
- Power supply and related ATS's.
- Totalizing panels.
- MDB-1 and MDB-2 panels.
- Power distributions panels within the renewed electrical room.
- Solar system thru BACnet Interface with Energy Management System (EMS) to be provided by the solar system specialist.
- Energy Management.
- Fire alarm and detection thru BACnet Interface to be supplied by Fire Alarm supplier.
- Security access control (future connection).
- The BMS concerning the cooling tower system and related chield water pumps must be interface with the proposed BMS.

1.6.2. The communication method between the different components of the BMS system (DDCs & Third-party Gateways) shall use the "BACnet or Modbus". All systems shall be compatible with the above standard protocols as applicable.

1.6.3. General Product Description:

a) The Building Manegement System (BMS) shall integrate multiple building functions including equipment supervision and control, alarm management, energy management and historical data collection.

b) The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, (DDC's), or (FPU's), Application Specific Controllers and operator devices.

c) System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC or FPU shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

1.7 Schedule of Control Functions

Schedule of control functions included in the Drawings or in this Specification is for the control and monitoring functions related to Electrical and future HVAC and related Plumbing Works.
The solar system equipment and devices must be interfaced with the BMS

1.8 Design Requirements

1.8.1. Design central processing unit with modular system architecture to allow expansion of processor memory and addition of application software programs, terminal units, and central memory units.

1.8.2. Minimum System Configuration: Accommodate input and output points, building systems data base, and functions specified and allow for 30% additional input/output points and related expanded data base, without modifying system hardware or software.

1.8.3. Future System Expansion: Design system to be expanded to accommodate 50% additional input/output points and related expanded data base, without modifying system hardware or software. Design application software programs and system database to be transportable to expanded central processing unit if required to accommodate specified future expansion.

1.8.4. Operator Data Terminal Unit: Provide operator interface functions through data terminal unit, including manual setpoints and overrides, data base display and maintenance, program loading and entry, operating system software functions, alarm display and acknowledge, graphic display, and operation logging.

1.8.5. Design operator display terminal data screens with the following features:
- a) Split screen display to allow entering commands and variables while observing status and alarm screen.
- b) Provide constant display of date, time, outside environmental conditions, and system status.
- c) Indicate off-normal conditions in a flashing display.

1.8.6. Design graphic display screens to present dynamic, interactive display of process variables and system status.

1.8.7. Layout data terminal units to allow operator to view displays, acknowledge system alarms and messages, manually enter data or commands, and communicate over telephone system from one seated position.

1.8.8. Central Control System: Perform the following functions:
- a) Perform optimisation routine.
- b) Display value of each input point.
- c) Display alarm when value of any input point exceeds preset minimum or maximum limit.
- d) Record each alarm indication.
- e) Record each operator-initiated action of control system
.

1.8.9. Design central communication system to control input and output between central processing unit, data memory units, remote control units, and data gathering units.
- a) Data Communication Network: Single distributed control network.
- b) Network Topology: Ring
- c) The communication must be compatible with RS485 to allowed communicated with the solar system.

d) Network Media: Twisted pair or as per specialist BMS recommendations
e) Network Protocol: Deterministic arbitration using token passing, master/slave arrangement.

1.8.10. Remote Control System:
provide the following functions and features:
a) Signal inputs
b) Control outputs
c) Data and program memory
d) Independent control and monitoring of local processes during failure of central control or central communication systems.

1.8.11. Design and build all system components to be fault-tolerant.
a) Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency
b) Static, transient and short-circuit protection on all inputs and outputs
c) Protect communication lines against incorrect wiring, static transients and induced magnetic interference
d) Network-connected devices to be A.C. coupled or equivalent so that any single device failure will not disrupt or halt network communication.
e) all real time clocks and data file RAM to be battery-backed for a minimum 72 hours and include local and system low battery indication.
f) It must be possible to receive and print out alarms at a central location even when the workstation at that location is non-operational or taken out of service for periodic maintenance.

1.8.12. Design system to continue operation of alarm display and printing at central location and operation of remote-control unit functions during removal or failure of central processing unit.

1.9 Qualifications

Manufacturer and installer to have an office staffed with factory trained engineers and technicians fully capable of providing instructions, routine maintenance and emergency maintenance service on all system components.

Manufacturer and installer to have at least 10 years experience in design and installation of Building Manegement system similar to performance to that specified herein and to provide evidence of experience as condition of acceptance and approval.

Supplier to have an in-place support facility with spare parts inventory and all necessary test and diagnostic equipment.

1.10 Quality Assurance

BMS shall comply with UL 916 and. All equipment used in system is to bear appropriate UL listing label/mark to ensure compliance.

Systems conforming to other equivalent international regulatory requirements will be accepted. The burden of proof for equivalent is on the Contractor.

1.11 Submittals

Submit in accordance with the Contract Documents:

- Shop Drawings: Indicate system configuration; interconnection wiring diagrams; location, data characteristics, range and units for each input and output point; logic diagram for each type of control routine; programming and operating reference for processing unit operating system; programming and operating reference for each application and programming language provided.
- Product Data: Provide for each component, including sensors, control drives and elements, plug-in circuit boards, and enclosed equipment units. Include cabinet dimensions, weights, and support point locations for each item of enclosed equipment.
- Design Data: Indicate basis of optimisation algorithms.
- Manufacturer's Installation Instructions: Indicate installation instructions.
- Manufacturer's Certificate: Certify system meets or exceeds listing requirements of Underwriter's Laboratories, Inc. for fire alarm and security equipment.
- Submit software provider's license agreement stating limits on use, copying, and transferring software.
- Manufacturer's Field Reports: Indicate acceptance of component and equipment installation, interconnecting wiring, and weekly progress on installation and start-up of system software.
- Technical Data Sheets: control and instrumentation technical data sheets (TDS) to be prepared for each advice.
- Loop Diagrams: control and instrument loop diagrams prepared and furnished for all instrument systems. Typical diagrams are not permitted. Loop diagrams are to be unique for each loop.
- Equipment Installation Plans: to indicate location of instrument junction boxes, individual field instruments, transmitter racks, and routing of cable duct from junction boxes to respective remote processing units and back to Control Room. This is to be accompanied by a list of control points connected by each DDC or FPU, with indication of related control functions. Interfacing provided is to be listed; these are to be grouped as per standard sub-module size of Digital and Analog input/output boards.Operating Consoles: drawings detailing operating consoles, instrument panel layouts and dimensions and control room plans.
- Instrument Installation: detail drawings for each field installation are to be furnished. Details are to include but are not limited to instrument piping details, transmitter rack details and pipe mounted equipment installation details.
- Logic Diagrams detailing the operational logic are to be completed for the digital binary operations. In addition to these drawings, operational logic descriptions are to be prepared detailing the sequence of operation and operational constraints and limitations.
- Instrument schedule listing all devices to be keyed to instrument loop number and device numbers. Instrument schedule to provide a comprehensive data source indicating where all specific information may be found for each service.
- Prior to procurement of equipment submit for approval the following drawings and documents:
- Process and instrumentation flow diagrams.
- Equipment Specifications and completed technical data sheets.
- Control logic diagrams and logic descriptions.
- Input/output points charts for every processing unit.

Prior to start of system installation and construction submit for approval the following drawings and documents:

- Shop drawings for transducers, transmitters, signal conditioners, indicators, recorders, miscellaneous instruments, central operator processing unit, consoles and ancillary.
- Control loop diagrams.
- Electrical elementary diagrams.
- Instrument installation plans.
- Detailed panel diagrams.
- Point to point wiring diagrams.
- Instrument schedule, including processing unit panel termination/interface.

Prior to commencing start-up-activities the following documents to be submitted for approval:

- System construction inspection procedures.
- Points calibration procedures.
- Calibrated control checkout procedures.
- Plant operational system test procedures.
- Operator and maintenance personnel training curriculum.

Prior to system acceptance and turnover and as a condition of system acceptance, the following documents are to be submitted in four copies in accordance with contract requirements

System user manual.

- Systems maintenance manual including Specifications of each piece of equipment, trouble-shooting charts, and preventing maintenance instructions, technical data sheet for each instrument referenced for each application.
- As-built drawings including equipment outlined dimension drawings, equipment wiring connection drawing.
- Complete supplementary information about software and hardware of system supplied. This to include:
  a. System block diagram (hardware)
  b. Software “functional” flow diagram
  c. Memory map of all units
  d. Specific tasks performed by each processor, especially where a distributed processing architecture is provided. These are to be clearly indicated in functional form.
  e. Source and object-lists of software program

1.12 Delivery, Storage and Handling

Deliver, store, protect and handle products to site under provisions of the Contract Documents.

Accept products on site and verify damage.

Protect products from construction operations, dust and debris by storing in conditioned space.

1.13 Maintenance Service

Furnish service and maintenance of building management system for two years from Date of Substantial Completion.

Include installation of software revisions issued during maintenance service period.

1.14 Spare Parts

As soon as practicable after approval of materials and equipment and, if possible, not later than 4 months prior to the date of beneficial use, submit spare parts data for each different item of equipment furnished. Data to include a complete source of supply, a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified hereinafter as EXTRA MATERIALS to be furnished as part of the Contract; and a list of additional items recommended by the manufacturer to assure efficient operation for a period of two years. The foregoing is not to relieve the Contractor of any responsibilities under the guarantee condition.

1.15 Extra Materials

Provide special tools required for maintenance.

Provide two of each plug-in circuit board.

Provide 1000 sheets of continuous form paper.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

Unless specifically mentioned otherwise, all controls and instruments specified shall be from internationally known manufacturers specialized in controls and having not less than 30 years of active production in controls.

- Delta Controls Inc.
- Honeywell, Inc.; Home & Building Control.
- Johnson Controls, Inc.; Controls Group.
- Siemens.
- or approved equal.

2.2 Networking Communications

Open integration support for standard protocols including BACnet and Modbus across multivendor devices.

2.2.1 Open protocol: specify interoperable field and network protocols such as BACnet, Modbus, KNX, and Lonworks-to prevent vendor lock-in across multi-brand equipment.

2.2.2 The design of the BMS shall network operator workstations and stand-alone DDC's in a peer-to-peer BACnet design scheme.

2.2.3 Access to system data shall not be restricted by the hardware configuration of the Building Management System. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.

a) Operator workstations and shall directly reside on a network such that communications may be executed directly between DDC's, directly between workstations and between DDC's and workstations.

b) Network design shall include the following provisions:

- Provide high-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any DDC is displayed at workstations and/or alarm printers within 5 seconds.
- Support of any combination of DDC's and operator workstations directly connected to the network.
- Message and alarm buffering to prevent information from being lost.
- Error detection, correction and retransmission to guarantee data integrity.
- Synchronization of real-time clocks.

2.2.4 Telecommunication Capability:

a) Auto-dial/auto-answer communications shall be provided to allow FPU's to communicate with remote operator stations and/or remote terminals on an intermittent basis via telephone lines, as indicated in the sequence of operations.
b) Provide all necessary hardware and software for remote communications with all remote processors, back-up processors and all operator input/output peripheral devices.

2.3 Central Processing

2.3.1 BMS hardware to be totally solid-state using computer oriented digital technology. System to have a fully modular architecture permitting expansion by adding computer memory, additional processing-units application software, operator peripherals and field hardware.

2.3.2 Main Station Processing Unit to be Workstation: Microcomputer with minimum configuration as follows:
a) Processor: Must be from the new products rely on the modern technology.
b) Random-Access Memory:16GB.
c) Cache Memory: 64MB.
d) Monitor: 43 inches LED type
e) Hard-Disk Drive: 80 GB.
f) Mouse: Three buttons.
g) Operating System: Microsoft Windows XP or later.
h) BACnet Conformance: Workstation shall support BACnet device and have minimum capabilities defined in PICS for the following areas:
- Network.
- Functional groups.
- Standard application services supported.
- Standard objects supported.

2.3.3 Field Processing Unit (FPU) or (DDC) Direct Digital Control to be distributed stand-alone for control of various unitary and terminal equipment or controls with built in network communication for integration into the BMS system.

2.3.4 Loading/Backup Facilities: provide as an integral of a PC, all hardware required to load, reload, or backup the memory of the system and the software to execute specified functions. Loading of system to be through use of high-speed, mass storage media, such as magnetic tape cartridge or floppy diskette. This same media to be used for making on-line system backups and for remote historical data storage.

2.3.5 Data Dumping: if FPU or DDC memory fails, the operator shall not have to manually re-enter system data. Necessary hardware and software are to be supplied to:
- Allow periodic dumping of operator-entered data onto another storage media on line.
- Reload this data as the operator desires.

- Data dumping are not to interrupt any other system operation (such as

operator input/output, scanning of field hardware, application software execution, etc...).

2.3.6 A user-friendly programming language is to be used to programme the FPU or DDC and the zone controller connected to it. Further the panel is to have the predefined software listed below:

- Input points
- Output points
- Pulse points
- Annual schedule
- Weekly schedule
- Daily schedule
- Alarm
- Controller
- Totalizer
- Trend log
- Zone controller access points
- Optimised start
- System display
- User access
- Scale range
- Load shed

2.4 D. FPU/DDC Controllers

2.4.1 Stand-alone Controllers shall be microprocessor Native BACnet Protocol based. They shall be multi-tasking, multi-user, real-time, digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this Specification and the attached function list.

2.4.2 Each FPU or DDC shall have sufficient memory to support its own operating system and database.

2.4.3 Each FPU or DDC shall have a minimum of 20% spare capacity for future point connection. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than two spares of each implemented I/O type. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.

2.4.4 FPU or DDC shall provide at least two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and potable operator’s terminals. FPUs shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers and terminals.

2.4.5 FPUs or DDC's shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or Analog indication of value shall be provided for each Analog output. Status indication shall be visible without opening the panel door.

2.4.6 Each FPU or DDC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components.

2.4.7 In the event of the loss of normal power non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
Upon restoration of normal power, the Controller shall automatically resume full operation without manual intervention.

2.5 FPU/DDC Resident Software Features

2.5.1 General:

a) All necessary software to form a complete operating system as described in this specification shall be provided.

b) The software programs specified in this Section shall be provided as an integral part of FPU/DDC Controllers and shall not be dependent upon any higher-level computer for execution.

c) Control Software Description:

i. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:
- Two-position control
- Proportional control
- Proportional plus integral control
- Proportional, integral, plus derivative control
- Control loop tuning

ii. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

iii. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

iv. Upon the resumption of normal power, each FPU/DDC Controller shall analyse the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

d) DDC Controllers shall have the ability to perform any or all the following energy management routines:
i. Time-of-day scheduling
ii. Calendar-based scheduling
iii. Holiday scheduling
iv. Temporary schedule overrides
v. Start-Stop Time Optimisation
vi. Automatic Daylight Savings Time Switchover
vii. Night setback control
viii. Enthalpy Switchover (economizer)

ix. Peak Demand Limiting
x. Temperature-compensated duty cycling
xi. Fan speed/CFM control
xii. Heating/cooling interlock
xiii. Cold deck reset
xiv. Hot deck reset
xv. Hot water reset

2.6 Portable Operator's Terminal (POT)

Provide one portable operator terminal with a minimum LCD display of 80 characters by 25 lines and a full-featured keyboard. The POT shall be handheld and plug directly into individual distributed control panels. Provide a user friendly, English language prompted interface for quick access to system information, not codes requiring look-up charts.

If the same Portable Operator's Terminal cannot be used for all control processors, provide separate POTs to accomplish the above functional requirements.

Portable operator terminal access to controller shall be password controlled.

2.7 Operator Peripheral Devices

General: operator peripheral device communications, here designated as Man-Machine Interface (MMI) to be handled simultaneously through various devices generally categorized as software and hardware. Each device may be connected in a direct proprietary, leased phone line, or dial-up phone line application.

Standards: all peripheral devices to utilize ASCII (American Standard Code for Information Interchange) code and to be interfaced to the processing units with standard RS 232 port. Communication versatility is to comply with all methods previously specified herein.

Operator Station to comprise multiple operator peripheral input/output devices which can all be used simultaneously.

Operator Access to system to be restricted by a software coding process. Systems which provide only manual key lock accessibility are not acceptable.

Printers: system printers to provide hard copy data retention of change of state, operator initiated actions, management reports, graphics and trended information. Printers, which can be interfaced, include the following:
- Latest A3 inkjet Colour printer
- Receive only (RO) printer

Main control station to be provided with one colour and two receive only printers. Secondary stations to be provided with one colour and one receive printer.

2.8 Field Devices and Controls

Provide all necessary transducers, level switches, pressure and temperature sensors, transmitters, etc. where applicable to satisfy all functions required.

2.9 Schedule of System Graphics:

2.9.1 Power Distribution System and Electrical control: System overview with indication of list feeders, main feeders, ties breaker status, by colour change. Show all control functions as per functional point list.

a) General Switchgear: Show all control functions as per functional point list.
b) Emergency power generators and the related main fuel tank.
c) Power supply and related ATS's.
d) Totalizing panels.
e) MDB-1 and MDB-2 panels.
f) Power distributions panels within the renewed electrical room.
g) Solar system interfaced with Energy Management System thru (EMS).
h) Energy Management.
i) General MV Switchgears: Show all control functions as per functional point list
j) Lighting Panel Boards: **(For future Connection)**

2.9.2 Fire Detection and Alarm

a) Fire Detection System: Overview schematic of detection / protection scheme.
b) Zone Alarm/Fault: Allow for backup advisory messages in case of alarms generation. Relay for action to be taken; mechanical equipment shutdown, etc..
c) For future related to the fire alarm system within the palace, Zone Alarm/Fault: Layout plans of each floor with colour change to indicate condition.

2.9.3 Security access control (future connection).

2.9.4 HVAC Control:

a) Must be linked with the BMS concerning the cooling tower and the related equipment and pumps.
b) Equipment: Show layout of all boilers, pumps, fans, as per mechanical drawings (future connection)
c) Control Points: Show all control points related to all equipment indicated above as per schedule of functional point list and control diagrams (future connection)

2.9.5 Plumbing Control: **(For future Connection)**

a) Domestic Cold-Water System: Show all control functions as per functional point list.
b) Fire Pump: Show layout plan, with location, by colour change status.
c) Location plan for each floor, indicating flow alarm devices and zone limits with colour change status.

2.10 Schedule of Functions to be Monitored and/or Controlled

- As per Mechanical BMS schedule of points (all points are physical points).
- As per Electrical BMS schedule of points (all points are physical points).
- Monitored through BACnet interface from fire control panels or fire suppression panels.

PART 3 - EXECUTION

3.1 Examination

Verify that conditioned control rooms are ready to receive work.

Verify field measurements are as shown on shop drawings and as instructed by manufacturer.

Verify that required utilities are available, in proper locations, and ready for use.

Correct unsatisfactory conditions.

3.2 Interface with other Products

Provision for future to connect HVAC control devices and lighting controls

Connect fire alarm and security access devices, electrical sensing and measurement devices, electrical controls and relays, programmable logic controller.

3.3 Field Quality Control

Test each sequence of building management system by simulation of normal, off-normal, and alarm conditions.

3.4 On-Site Testing

3.4.1 Provide Engineer-approved operation and acceptance testing of the complete system. The Engineer will witness all tests.

3.4.2 Field Test: When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on line. All testing, calibrating, adjusting and final field tests shall be completed. Provide a detailed cross check of each sensor within the system by making a comparison between the reading at the sensor and a standard traceable to the National Bureau of Standards. Provide a cross check of each control point within the system by making a comparison between the control command and the field-controlled device. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power. Submit the results of functional and diagnostic tests and calibrations to the Engineer for final system acceptance.

3.4.3 Compliance Inspection Checklist: Submit in the form requested, the following items of information to the Engineer for verification of compliance to the project specifications. Failure to comply with the specified information all constitute non-performance of the contract. The Contractor shall submit written justification for each item in the checklist that he is unable to comply with. The Engineer will initial and date the checklist to signify Contractor’s compliance before acceptance of system.

a) Verify to the Engineer in letter form that supplier has in-place support facility.

Letter shall show location of support facility, name and titles of technical staff, engineers, supervisors, fitters, electricians, managers and all other personnel responsible for the completion of the work on this project.

b) Manually generate an alarm at a remote Controller as selected by the Engineer to demonstrate the capability of the workstation and alarm printer to receive alarms within 5 seconds.

c) Disconnect an operator workstation in the central control room and manually generate an alarm at a remote Controller to demonstrate the capability of the system printer to receive alarms when the workstation is disconnected from the system

d) Disconnect one Controller from the network to demonstrate that a single device failure shall not disrupt or halt peer-to-peer communication. Panel to be disconnected shall be selected by the Engineer.

e) At a Controller of the Engineer's choice, display on the portable operator's terminal:
   - Setpoints and status conditions, i.e., on or off for a system or piece of equipment attached to that panel as well as for points at another Controller on the network, as selected by the Engineer.
   - The diagnostic results as specified for a system or piece of equipment attached to that panel as well as for a system or piece of equipment attached to another Controller.
   - The ability to add a new point to the Controller with the POT and have it automatically uploaded to the workstation to modify that panel's stored database.

3.5 Field Services

Adjust setpoints, alarm points, and display configurations so that system performs as specified.

Include installing and debugging hardware and software. Perform hardware configuration revisions required to accommodate software patches.

Enter building management database and provide backup copy.

3.6 Cleaning

Clean equipment finishes interiors of equipment cabinets.

3.7 Service and Guarantee

3.7.1 General Requirements: Provide all services, materials and equipment necessary for the successful operation of the entire BMS system for a period of one year after completion of successful performance test. Provide necessary material required for the work. Minimize impacts on facility operations when performing scheduled adjustments and non-scheduled work.

3.7.2 Description of Work: The adjustment and repair of the system includes all computer equipment, software updates, transmission equipment and all sensors and control devices. Provide the manufacturer's required adjustment and all other work necessary.

3.7.3 Personnel: Provide qualified personnel to accomplish all work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

3.7.4 Schedule of Work: Provide two minor inspections at each month interval and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude, and all work required as specified. Minor inspection shall include visual checks and operational tests of all equipment delivered. Major inspections shall include all work described for minor inspections and the following work:

a) Clean all equipment, including interior and exterior surfaces.
b) Perform signal, voltage and system isolation checks of system workstations and peripheral.
c) Check and calibrate each field device. Check all Analog points and digital points.
d) Run all diagnostics and correct all previously diagnosed problems.
e) Resolve and correct any previous outstanding problems.

Provide detailed report after each inspection.

3.7.5 Emergency Service: Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. Furnish Owner with a telephone number where service representative can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service. Restore the control system to proper operating condition within 3 days.

3.7.6 Operation: Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the initial performance test.

3.7.7 Systems Modifications: Provide any recommendations for system modification in writing to Owner. Do not make any system modifications, including operating parameters and control settings, without prior approval of Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

3.7.8 Software: Provide all software updates and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and shall be incorporated into the operations and maintenance manuals, and software documentation.

3.8 Demonstration

Provide systems demonstration under provisions of the Contract Documents.

3.9 Training

3.9.1 The Contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours as follows:

3.9.2 Training shall include:

a) Explanation of drawings, operations and maintenance manuals.
b) Walk-thru of the job to locate control components.
c) Operator workstation and peripherals
d) Controller operation/function
e) Operator control functions including graphic generation and field panel programming.
f) Operation of portable operator's terminal.
g) Explanation of adjustment, calibration and replacement procedures.

3.9.3 Provide additional training quarterly for a period of one year from final completion of the project.

SECTION 260519
LOW VOLTAGE & MEDIUM VOLTAGE ELECTRICAL POWER CABLES

SECTION 260519
LOW VOLTAGE & MEDIUM VOLTAGE ELECTRICAL POWER CABLES

A- GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement, installation, testing and commissioning of all electrical conductors and cables as indicated on the drawings, and/or specified herein and in accordance with the Contract Documents. Work includes but is not limited to the following:
   1. Electrical power distribution cables (copper)
   2. Wires (copper).
   3. Accessories.

1.02 REFERENCES

A. The cable installation shall comply with EDL and local regulations or the following International Standards (as applicable):

1	BS 3924	Specification for Pressure-Sensitive Adhesive Tapes for Electrical Insulating Purposes
2	BS 5467	Specification for Armoured Cables with Thermosetting + IEC 502 Insulation for Electricity Supply
3	BS 5468	Specification for XLPE Cables
4	BS 6004	Specification for PVC-Insulated Cables (non-armoured) for + IEC 227 Electric Power and Lighting
5	BS 6121	Specification for Mechanical Cable for Elastomer and Plastics Insulated Cables
6	BS 6346	Specification for PVC-Insulated Cables for Electricity Supply
7	BS 6360	Specification for High Conductivity Plain Annealed Stranded Copper Conductor
8	BS 7671	Requirements for Electrical Installations
9	BS 4121	Mechanical Cable Glands
11	BS 6121	Code of Practice for Selection, Installation and Inspection of Cable Glands used in Electrical Installations
12	IEC or an equivalent international standards	

1.03 SUBMITTALS

A. Refer to Section 16010 “Basic Electrical Requirements”.

Part 2 - PRODUCTS

2.01 GENERAL

A. Provide as described herein all cables and wires, cable glands, lugs and all accessories which are required for proper installation and termination of the cables and wires.

B. Cables Manufacturer:
   1. Liban Cables
   2. Or approved equal

C. The products and manufacturers specified herein, are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.

2.02 CABLES

A. General
   1. Provide cables complete with all necessary jointing, termination materials and other accessories of size and type as indicated in the Specifications and on the drawings.
   2. All cables shall have stranded copper conductors. Multicore armoured cables shall be armoured with a single layer of helically wound galvanized steel wires and protected overall with an extruded PVC over sheath.
   3. Unless otherwise indicated on the Drawings all cable over sheaths shall be black for low voltage cables suitable for use on a 3 phase, 50 Hz alternating current system. All cables shall be of a voltage grade appropriate to the voltage of the system to which they are to be connected.
   4. The Contractor shall be responsible for making accurate measurements regarding cable lengths on site after agreement of actual cable routes with the Engineer and for adding whatever allowances are necessary to cover cutting, snaking in trenches allowance for prescribed bending radius over linear lengths and wastage.
   5. Immediately after testing to the Engineer’s satisfaction, both ends of every cable length shall be sealed. Plastic cables shall be sealed by means of a plastic cap embracing the armour wires and the outer sheath. Cable ends shall be marked in accordance with the relevant British Standard. Where necessary, pulling eyes may be fitted to cables at the

manufacturers' Works provided that the approval of the Engineer is first obtained. Copper conductors for mains cables shall comply with BS 6360.

6. Proper cable glands to BS 6121 of brass material shall be used for cable entries into distribution boards and equipment. Such glands shall be covered with purpose made rubber sleeves.
7. Cables shall be of the following types with sizes as indicated on the Drawings:
    a. PVC/PVC Cables: PVC insulated PVC sheathed cables shall be 600/1000V, single or multi-core conforming to BS 6346 or equivalent standards with high conductivity plain annealed stranded copper conductors to BS 6360, PVC insulated with an extruded layer of PVC bedding and a final outer extruded PVC sheath. The insulation and sheath shall be to BS 6746 with insulation coloured to identify phases and neutral in accordance with BS 6746C.
    b. PVC/SWA/PVC Cables: PVC insulated single wire armoured and PVC sheathed cables shall be 600/1000V, multi-core conforming to BS 6346 with high conductivity plain annealed stranded copper conductors to BS 6360, PVC insulated with an extruded layer of PVC bedding having a single layer of galvanized steel wires armoured for multi-core cables and aluminum wires BS 1442 or tape BS 2897 for single core cables and a final outer extruded PVC sheath. The insulation and sheath shall be to BS 6746 with insulation coloured to identify phases and neutral in accordance with BS 6746C.
    c. XLPE/SWA/PVC and XLPE/PVC Cables: XLPE insulated single wire armoured and PVC sheathed cables shall be single core or multi-core cables, 600/1000V con-forming to BS 5467 with high conductivity plain annealed stranded copper conductors to BS 6360, insulated with cross linked polyethylene (XLPE) to BS 5468 applied by a combined extrusion and vulcanization process to form a compact homogeneous layer, cables bedded and overall sheathed by a black PVC layer to BS 6746. Armoured cables shall have a single layer of galvanized steel wires BS 1442 for multi-core cables and aluminum wire or tape BS 2897 for single core cables.

B- Medium Voltage cables:

1. **General:**

1.01: Works covered by the contract
a.11 KV cables with the related accessories

1.02: Standards and References
a. BS-6360: Insulated copper conductors cables and wires
b. IEC-502: rigid insulated power cables
c. IEC-228
d. IEC-287

1.03: Definitions & Submissions:
a. Providing all data sheet from the factory regarding the size and type of medium voltage cables that will be used on the site.
b. Providing test certificate concerning the MV. Cables
c. Providing connection detail for the medium voltage cables, at the transformer of the medium voltage switchgear.
d. 3 × 70 mm^2 XLPE armored PVC red color cable must be used for transformer 1600 KVA

e. The medium voltage cable must be installed underground in electrical channel between medium voltage cabinet and the step down transformer (11/0.4 KV)

SECTION 260526
GROUNDING AND BONDING

SECTION 260526
GROUNDING AND BONDING

1. GENERAL

1.1 SUMMARY

A. Section Includes: Design, procurement, installation, testing and commissioning of complete earthing system, all as indicated on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   - Earth Pits
   - Earth Electrodes (Rods, Tapes etc)
   - Earthing Conductors
   - Main Earthing terminals or bars.
   - Accessories and termination fittings, bonding, welding kits and other materials.

1.2 SUBMITTALS

A. Product Data: Submit to the Engineer for information only in accordance with the requirements of the Contract Documents, copies of manufacturer's specifications and installation instructions and other data to show compliance with these Specifications.

B. Shop Drawings: Submit shop drawings for all components for review by the Engineer. Include complete earthing systems, other accessories required, exact routing main earth conductors, location, dimension of earth pits, number of earth rods, and details of clamps, etc.

C. Sample: Submit to the Engineer in accordance with the requirements of the Contract sets of samples for earth materials for approval.

2. PRODUCTS

2-1 EARTHING SYSTEM

A. Provide complete earthing system in strict accordance with EDL and IEE requirements. Generally, all the electrical Panels; frames metal and structures and of the generators equipment shall be connected to the earthing system

- Separate earthing system must be installed for MV. Switch gear
- Separate earthing system must be installed for 1600 KVA transformer.
  Or using the existing earthing system related to EDL after verifying its suitability, following the necessary inspection.

B. Earthing Materials:
   - Furse, U.K.
   - A.N. Wallis & Co., U.K.
   - Kingsmill UK.
   - Approved equal.
   - The products and manufacturers specified herein, are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.

2-2 MATERIALS

A. The main earth bars shall be constructed of high conductivity copper, tape conductor to BS 1432.

B. Unless specified otherwise, the cross sectional area of protective conductors shall be in accordance with the relevant IEC and BSI standards and EDL Regulations.

2-3 EARTH ELECTRODES

A. Earth electrodes shall be copper clad steel rods of not less than 19 mm diameter, minimum 2 meters long or in 2 sections coupled. The earth rods shall be manufactured by fusion weld process resulting in an electrolytic copper sheath homogeneously welded to an inner steel core. The thickness of the copper sheath shall be approximately 10% of the overall rod diameter. Copper electroplated steel is not acceptable.

B. One end of the rod shall be pointed without application of heat and with driving head at other end. The sectional rods shall be coupled with strong bronze couplers. The coupler shall be threaded to fit the rod section. For driving the rod into the ground threaded steel shall be used.

C. A brass clamp of suitable size shall be provided for clamping the earth copper tape to earth rod. The rod shall be driven into the earth by means of a power hammer. The top of the earth electrode shall be housed in appropriate brick lined pit with removable medium duty cast iron cover for periodical testing of the electrode.
D. Earth pits shall be reinforced concrete construction of size 320 x 320mm to the depth of 300mm minimum or as approved by EDL. Earth pit cover shall be embossed with “Earth Sign”.

3. EXECUTION

3-1 EARTHING

A. All metallic equipment enclosures, steel structure system, all non-current carrying metal parts of the electrical systems and any other equipment or system components required by EDL, and IEE regulations shall be earthed in an approved manner.
B. All earth continuity conductors shall terminate finally at the main earth bus bar.
C. The earthing system connected to the earth bus on the main low tension switchboard. The neutral shall not be used for earthing and shall be connected to the earth only at the main low tension switchboard
D. The earth wires shall be covered with PVC and distinguished by Green color.
E. The earth tape shall be connected to the low tension switchboard earth bus.
F. All distribution boards shall be provided with an earth bus or earth terminal.

3-2 CONNECTIONS

A. Connection between earth bars and equipment frames and stranded copper cables shall be made with appropriate compression lugs, bolts, nuts and lock washers. Contact surfaces shall be thoroughly cleaned and tinned or thermo welded connections can be used.

B. Lugs, bolts, nuts, washers, screws, clamps, cleats and other items which come into direct contact with copper earth bars, tapes, cables, etc., shall be non-ferrous and manufactured from brass, bronze or other suitable conducting material which will not cause electrolytic corrosion. Connection between copper and galvanized structures shall additionally be tinned.

C. Earthing tapes shall be of continuous unbroken lengths. If jointing becomes absolutely necessary, then, after obtaining approval of the Engineer the tapes shall be joined by fusion welding 'Themoweld' or similar process.

D. The earth bus in the main switchboard shall be connected.
E. The maximum overall earth resistance between any point on the earth installation and general mass of the earth shall be less than 3 ohm in accordance with EDL regulations. If this resistance cannot be obtained with two earth rods, additional earth rods or sectional earth rods shall be used to obtain the required resistance. Parallel connected earth rods shall be spaced at a distance of not less than the rod lengths and connected by 70 mm^2 copper cables. If approved by the Engineer, earth plates or other earthing means may be used instead of the additional earth rods.

F. Measurement of earth resistance shall not be made within 48 hours after rainfall.
G. The connection between earth conductors and earth rods shall be made by means of high strength corrosion resistant copper alloy connector clamps and brazed.
H. The tops of the electrodes shall be protected from any damage and shall be easily accessible being enclosed in pits equipped with covers. The presence of the electrode shall be indicated in English.

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEM

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEM

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, procurement and installation of all conduits for wires, cables and mechanical protection and raceway systems, complete with all accessories, fittings, boxes, etc., as indicated on the drawings specified herein and in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   1. Rigid PVC conduits and fittings.
   2. Rigid metal conduit and fittings.
   3. Flexible metal conduit and fittings.
   4. Cable trunking and accessories.

1.02 REFERENCES

A. The following international Standards:
   1. BS 31 : "Specification for Steel Conduit and Fittings for Electric Wiring".
   2. BS 729 : "Specification for Hot Dipped Galvanized Coatings on Iron and Steel Articles".
   3. BS 731 : "Flexible Steel Conduit for Cable Protection and Flexible Steel Tubing to Enclose Flexible Drives".
   4. BS 4568 : "Specification for Steel Conduit and Fittings with Metric Threads of ISO form for Electrical Installations".
   5. BS 4607 : "Part 1 - Non-Metallic Conduits and Fittings for Electrical Installations: Rigid PVC conduits and Fittings Metric Units".
   6. BS 4662 : "Specification for Boxes for the Enclosure of Electrical Accessories".
   7. BS 6053 : "Conduit Diameter and Threads for Conduit and Fittings" + IEC 423A
   8. BS 6099 : "Conduits for Electrical Installations".
   9. BS 7671 : "Requirements for Electrical Installations".

B. The applicable provisions of the following standard publications codes and specifications shall apply throughout the Contract.
   1. CEE Publication No. 26.
   2. EDL.

1.03 SUBMITTALS

C. Refer to Section 16010 “Basic Electrical Requirements”.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A.
1. B-Line Systems, Inc. (U.S.A)
2. Niedax (Germany)
3. Swifts (U.K)
4. OBO Bettermann (Germany)
5. Or approved equal.

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

2.02 GENERAL

A. Provide wiring materials and devices as described herein including, PVC conduits, metallic conduits and metallic boxes, steel flexible conduits, steel trunking, and accessories all with fittings, supports and hardware as necessary.

B. The fire resisting caulking compound for the sealing of trays, trunking, conduits, cables, ducts, pipes and sleeves shall be of a putty-like consistency workable with hands at temperatures as low as 0° C and shall not slump at a temperature of 150° C. The caulking compound shall be intumescent type complying with applicable international and local standards, with a fire rating to suit the rating of the structure being breached, and having fast drying properties, becoming tack free in approximately 30 minutes. The compound shall readily caulk or adhere to clean surfaces of the following: asbestos-cement conduit, concrete, masonry, lead, rubber, polyethylene, polychloroprene or polyvinylchloride sheaths of cables; and the common metals. The compound shall form a seal with the foregoing without dissolving, noticeably changing characteristics, or losing any of the ingredients. The compound shall have no injurious effects upon the hands of workmen or upon the materials to which it is being applied.

   Alternatively provide RGP pipe seals and insert blocks with two long halves which fit around the pipes may be used. It is very important to choose the right size of blocks to obtain a perfect seal. The flexible modular system blocks shall be made from halogen free polymer rubber material hard enough to withstand lot of stress but yet soft enough to be compressed to ensure complete tightness around the pipes. The insert blocks which seal around the pipes and the solid spare blocks which fill in surplus room in the frames shall be certified by Lloyd’s for fireproof applications.

All materials for caulking and sealing around cables, conduits, pipe sleeves, etc., though fire rated walls or floors, shall be Civil Defense approved and comply with BS476, ASTM, UL, FM approved. These materials are to be provided by the Contractor.

2.03 CONDUIT SYSTEM

A. General
1. Provide complete conduit system including all necessary fittings, supports, accessories and hardware, whether or not indicated on the drawings or defined in detail in these Specifications.
2. Conduit raceways and fittings shall be used for various systems as follows unless specifically indicated otherwise on the drawings:
   a. uPVC ducts shall be used underground with concrete encasement below roads, concrete structures.
   b. Metallic conduit raceways shall be used for all exposed installations in plant rooms, substation, battery rooms, generator rooms, electrical rooms, communication closets, elevator rooms and shelters.
   c. PVC conduit raceways embedded in concrete or concealed in walls, partitions and ceiling voids, shall be used for all wiring within internal building areas unless otherwise specified.
   d. Flexible steel conduit with rubber/PVC jacketing shall be used where connections to equipment may be subject to vibration.

B. Metallic Conduits
1. Metallic conduits shall be steel conforming to BS 31 Class ‘B’ or BS 4568 Class-4 and CEE Publication 23 as a minimum, hot-dip galvanized inside and outside with screwed ends. Conduit fittings shall be malleable iron, galvanized, with threaded spouts suitable for the number and arrangement of conduits connecting to them.
2. Couplers, unions, saddles, hangers, straps, etc., shall be employed for connection and fixing of conduits in a permanent and rigid manner and these shall be all of galvanized steel, to BS 31 or BS 4568.
3. Use of inspection type elbows, bends, tees and manufactured bends shall be avoided wherever possible. Where impracticable to set conduit, normal factory made bends may be used where approved by the Engineer.
4. Steel conduits shall be continuous from outlet to outlet to distribution boards, junction or pull boxes and secured to all boxes so that each system is electrically continuous from service to outlet. Conduits shall be screwed tightly into couplings and fittings and connected to un spouted accessories such as distribution boards, switch and socket boxes by couplers and male brass bushes to ensure earth continuity.
5. Steel conduit ends shall be cut square and reamed to remove burrs and sharp edges. No more screw threads shall be exposed than necessary and all exposed threads shall be coated with ‘Galvanite’ paint immediately after erection. Bends in conduits shall be neatly made with proper bending machine and so formed that there is no cross sectional distortion of conduits.

Conduits shall be fixed to surfaces by distance saddles spaced at even intervals not exceeding the distance stated below.

Conduit (Diameter)	Spacing of Supports (Metre)
Up to 25 mm 32 and 38 mm 50 mm	0.60 0.90 1.00

6. All conduit expansion couplings used shall be fabricated from material equal or equivalent to that of the conduit with which the coupling is to be used, having factory installed packing ring and pressure ring to prevent entrance of moisture. All expansion couplings shall be equipped with earthing ring or earthing conductor.
7. All conduit runs shall be fixed using spacer bar pattern saddles giving not less than 3mm clearance between the conduit and the surface to which it is fixed. Saddles shall have finish to match the conduit and saddle clips shall be secured to the bar by means of brass screws.

C. Metallic Conduit Boxes

1. Metallic Conduit Boxes shall be used throughout metallic conduit raceway systems, and shall comply with, or be of demonstrated equivalent quality and confirming to BS 4662 and BS 31 requirements. All boxes and covers shall be galvanized, zinc plated or equal rust proofed finish equivalent to conduit finish.
2. Circular and/or rectangular boxes shall be used for pull boxes and terminating boxes, according to size and number of conduits to box. Boxes shall be either malleable iron or heavy duty steel construction with welded joints and tapped holes to receive threaded cover retaining screws. Self-tapping screws will not be permitted.
3. All boxes, other than those to which a fitting or accessory is to be directly mounted, shall be fitted with covers screwed to the box by brass screws. Malleable iron covers shall be used with malleable iron boxes and heavy gauge steel covers shall be used with sheet steel boxes.
4. All cover and accessory fixing provisions shall be so positioned that the fixing screws lie completely clear of cables entering the box. All fixing screws shall be brass.
5. All boxes installed in exterior locations, plant rooms, ducts, etc., shall be fitted with approved type gaskets to provide a waterproof seal between box and cover or other item fitted to the box.
6. The sizes of conduits shall be in accordance with the number and sizes of wires to be drawn inside them as indicated in IEE or latest EDL regulations but no conduit smaller than 20mm shall be used. A pull wire or tape shall be provided in all empty conduits with no less than 200mm of slack left at each end.

7. All boxes other than those on which accessories or any item of equipment is to be mounted, or at which flexible connections are to terminate, shall be provided with internal fixed brass earth terminals.
8. All boxes provided as junction boxes where cable joints are specified or permitted, shall be provided with fixed terminal blocks. Such boxes shall be of adequate size to contain the terminal block and sufficient cable to allow neat connections to be made. The terminal blocks shall be fixed to the box by brass screws and shall comprise brass conductor connectors, with brass clamping screws enclosed in porcelain or other heat resisting insulation material which will not distort or otherwise have its properties damaged by temperatures below the highest temperature at which the insulation of any cable connected to it is destroyed.

D. Flexible Steel Conduit
1. Flexible steel conduit shall consist of flexible corrosion resistant steel core with a watertight, synthetic jacket extruded over the conduit and a continuous copper earth tape under the jacket.

E. Conduit Fittings
1. Conduit fittings shall match the style, material and finish of the conduit to which they are connected.
2. Expansion fittings shall be telescoping sleeve type incorporating neoprene gaskets or other means to provide a watertight assembly. Expansion fittings used with rigid steel conduit shall be designed to maintain earth continuity by means of internal devices such as copper wiring glands or copper bonding straps. Exposed expansion fittings used with rigid steel conduit shall be furnished with external clamps and copper bonding jumper.
3. Expansion/deflection fittings shall consist of threaded steel hubs, an inner sleeve, outer neoprene jacket, stainless steel straps, and internal copper braid bonding jumper. Fittings shall be watertight.
4. Fittings used with flexible steel conduit shall be designed specifically for use with the conduit installed. The fitting body shall thread into the flexible core of the conduit and shall be retained by a compression device to prevent pull-out. The fitting shall maintain earth continuity of the conduit system and shall provide a watertight connection.

F. Flexible Connections
1. Where connections to electric motors, equipment, etc., are to be by multicore cable, the final termination shall be by ring type universal glands and locknuts, and adequate slack cable in the form of a loop or spiral being left to allow for the movement of motors necessitated by belt re-tensioning, vibration, etc.
2. Where the connections are to be by insulated conductors in conduit, the final termination shall be via flexible conduit as specified elsewhere herein.

G. PVC Conduits

1. PVC conduit shall be high impact, non-hygroscopic, rigid PVC unthreaded push type. Conduits shall be in accordance with BS 6099 Heavy Gauge (standard) and conduit fittings shall be in accordance with B.S. 4607 and CEE Publication 26. The conduits and fittings shall be suitable for installation at temperature -5 to +85° C and they shall not soften or suffer any degradation at these temperatures. Conduits and fittings shall be of the self-extinguishing type.
2. All boxes and extension rings shall be fitted with tapped brass inserts for fixing screws.
3. PVC conduits and fittings shall be joined by using sealing cement (vinyl solvent paint) to ensure a watertight joint. The cement shall be of a type that remains in a sticky condition. When PVC conduits are embedded in concrete slabs, they shall be securely held in place by fixing to shuttering and reinforcing bars. In walls they shall be run in cut chases and fixed by saddles or crumpets.
4. Chases shall be deep enough to allow full thickness of plaster cover to be applied. Bends in PVC conduits shall be neatly made with a proper size bending spring.
5. Except when embedded in concrete slab, all conduits shall be installed parallel to the lines of the building and at a minimum of 100 mm away from pipes or other non-electrical services. Boxes shall be fixed independently to the building so as not to be supported by the conduits. Empty conduits when left with ends exposed for some time shall be closed with suitable plugs to prevent entry of dirt and foreign matter.
6. Conduits shall be installed in such a manner to prevent trapped condensation. Pull boxes shall be provided as required for easy drawing of wires and shall be in readily accessible locations and levels with covers fixed by brass screws.
7. No wire is to be drawn inside conduits until they are completely erected and approved by the Engineer. The conduits shall be swabbed through to remove any dirt or loose matter before drawing of wires.
8. The sizes of conduits shall be in accordance with the number and sizes of wires to be drawn inside them as indicated in IEE or latest EDL regulations but no conduit smaller than 20mm shall be used. A pull wire or tape shall be provided in all empty conduits with no less than 200mm of slack left at each end.

2.04 TRUNKING SYSTEM

A. General

1. Provide complete trunking system, including all necessary fittings, supports, accessories and hardware, whether or not indicated on the drawings or defined in detail in these Specifications.

B. Steel Trunking

1. All cable trunking shall be steel trunking complying with ASTM 36 or equivalent fabricated from sheet metal not less than 1.6mm thick and finished hot dip galvanized, conforming to BS EN 1461.
2. Trunking shall not be smaller than the minimum size stated on the drawings or specified herein and shall be as per EDL regulation. The Contractor shall check the minimum size of trunking specified to ensure that it is large enough for his requirements.
3. The trunking manufacturer's bends, tees and offsets shall be used wherever possible. Any purpose made units shall be constructed with brazed pop-riveted or welded joints and designed to present no sharp edges etc. All finishes must be carefully re-instated. All bends and tees shall have gussets or be radiused.
4. Multi-compartment trunking shall be used where segregation is required. Cables from one compartment shall not pass through any other compartment at tee and intersection junctions and neither shall the capacity of any compartment be reduced for the sole purpose of making such junctions. At junctions the tee leg, or in the case of an intersection, the smaller trunkings shall butt-finish to the uncut sides of the main trunking and a tee or four-way intersection fitting with legs of width to match the joining trunkings and blank ends shall be mounted over the junction in place of the covers.

   This fitting shall be sectionalized to match the compartmentation of the secondary trunkings and be provided with bushed rear entries of the maximum areas obtainable without destroying the total segregation of the compartments. Cables required to pass from the main through run of trunking to the intersecting run shall be routed through the fitting.
5. Vertical runs of trunking shall be provided with heat barriers at intervals not greater than those prescribed in the IEE. Regulations to prevent undue temperature rise in the upper levels of the run. These barriers may be combined with the fire smoke barriers where the spacings are compatible.
6. Cable retaining clips for use where trunking is installed with cover in any plane other than upper most shall be supplied by the manufacturer for that purpose and be made from galvanized or sherardized material. The clips, preferably of the spring 'W' wire type, shall fit snugly behind the trunking body return lip, and shall have any sharp edges removed.
7. Cable support fittings for use in vertical trunking shall be of the 'projecting pin' type fixed to the gutter body by at least 2 machine screws. Cables should be passed through the pins in a 'snaking' fashion so that the weight of the hanging cables is not passed through the cable support fitting. The pins must be insulated with 1000 volt grade 'heat shrink' PVC sleeving fitting tightly over the entire projection of the pin. Supports shall be fitted at intervals and not greater than prescribed in the IEE Regulations.

C. Service Outlet Box and Junction Box

1. Service outlet boxes and junction boxes shall be of the size as required and constructed from high pressure Zinc Alloy die casting base frame and fixed on to heavy gauge galvanized steel base plate for support by support frame and other materials adequate in strength and performance and to be protected against corrosion. The design of the base frame shall cast the whole unit in one piece without any joints/fabrication to prevent corrosion and concrete shippage into the box during casting of concrete or screeding. The boxes shall be constructed with provisions for ducting or conduit access on all four sides. Unwanted entries shall be blanked off with detachable side blanks.
2. Cover for service outlet boxes shall be made of high pressure Zinc Alloy die casting with 6mm recess to receive thermoplastic, tiles or carpet and provided with suitable hinges designed to enable the trap cover to open through 180 degrees and giving access at all times to the power, telephone and computer outlets. Covers for junction boxes shall be made of high pressure zinc alloy die casting secured by counter sunk screws, with 6 mm recess to receive thermoplastic tiles or carpet. All exposed portion of the boxes shall be epoxy coated in gray color.
3. All boxes shall be adjustable in height independently of the trunking system to take account of difference in floor thickness.
4. Adequate segregation shall be provided between service runs within junction boxes by using crossover bridges and rigid compartments.
5. Cables emerging from service boxes shall be protected against damage by means of nylon cables exit grommets or equivalent and approved material and shall be reversible to close position when not in use. The lifting handle and cable grommets shall be provided in opposite sides of the trap cover to allow easy access to lifting handle and to avoid damage of the cable insulation.
6. All boxes shall be complete with waterproof gasket and circuit protective conductors between the covers and the boxes.
7. The power compartment shall be equipped with service outlets as shown on the drawing.
8. The under-floor ducts, service outlet boxes, junction boxes, all other accessories shall be from the same manufacturer.

Part 3 - EXECUTION

3.01 CONDUIT AND FITTINGS

A. General

1. Exposed rigid conduit shall be installed parallel or at right angles to walls and ceiling beams and a minimum of 100mm away from pipes or other non-electrical services. All changes in direction shall be made with approved bends, elbows, and pull boxes.
2. The spacing between parallel runs including curved sections, shall be uniform throughout.
3. Where conduit runs are to be concealed in the structure or are to pass through floor slabs, the Contractor shall be responsible for marking the accurate positions of all chases and holes.
4. Conduit installation on shear walls shall be kept to a minimum, routings necessary on shear walls shall be agreed with the Engineer before work is put in hand.
5. Conduits shall be installed in such a manner to prevent trapped condensation. Pull boxes shall be provided as required for easy drawing of wires and shall be in readily accessible locations with covers fixed by brass screws. Pull boxes/draw boxes shall be labelled properly for identification. Boxes shall be fixed independently to the building so as not to be supported by the conduits. Empty conduits when left with ends exposed for some time shall be closed with suitable plugs to prevent entry of dirt and foreign matter.
6. No wire is to be drawn inside conduits until they are completely erected and approved by the Engineer. The conduits shall be swabbed through to remove any dirt or loose matter before drawing of wires.

B. Conduit Supports

1. Exposed rigid conduit shall be held securely in place by approved hangers and fasteners. Conduit concealed above suspended ceilings or under the raised floors shall be supported from the slab above the ceiling or from the slab below the raised floors in the same manner as exposed conduits and shall not be supported from ceiling hangers or raised floor supports.
2. Conduits shall be supported by hangers and pipe straps or clamps spaced not more than 1.5m and within 15cm of boxes and fittings which are not independently supported.
3. Conduit supports shall be fastened to building features by cast-in-place, threaded inserts or explosive charge studs in concrete; expansion bolts or toggle bolts in masonry; galvanized bolts, machine screws and clamps on steel work; or as otherwise approved by the Engineer.

C. Conduits in Concrete/Masonry

1. Conduits in concrete shall be installed as close to the middle of the concrete slabs or walls as practicable without disturbing the reinforcement.
2. The outside diameter of the conduit shall not exceed one-third of the slab or wall thickness and conduits shall be placed not closer than three diameters on centers, except at cabinet or box locations where indicated on the drawings.
3. Spacing between the embedded conduits shall not be less than the largest aggregate used in concrete mixer.
4. Conduits ready for casting shall be well secured to the reinforcement steel with seam at every 1500mm run interval.
5. The draw boxes/pull boxes ready for casting shall be filled with wet paper or polyethylene.
6. When conduits are embedded in concrete slabs or walls they shall be securely held in place by fixing to shuttering and reinforcing bars. In masonry unit walls they shall be run in the hollow spaces of the blocks as the work proceeds.
7. Chases if required in solid masonry unit walls or in concrete after casting shall be deep enough to allow full thickness of plaster cover or other finish to be applied. Chasing in concrete will generally not be permitted; all conduits must be “cast-in” unless expressly authorized otherwise by the Engineer.
8. Where conduits are to be cast into concrete slabs which will subsequently support suspended ceilings or other services using hangers, brackets, or the like bolted to the soffit, mark the positions of all such conduit runs on the inside of the formwork before fixing the slab reinforcement, using a suitable coloured marker in order to leave a clear imprint of the conduit network on the soffit of the slab after formwork is stripped. Ensure that no embedded conduits are damaged during drilling operations for hangers, supports, etc.

D. Sleeves

1. Provide and set all necessary sleeves in advance of pouring of slabs or construction of walls.
2. Sleeves in Exterior Walls and Floors shall be galvanized steel pipe complete with pre-manufactured sealing rings and pressure bushings of proper size. Keep pressure bushings accessible for future tightening.
3. Sleeves through floors shall be extended 50mm above finished floors unless otherwise shown. All sleeves for future use shall be capped.
4. Sleeves in electrical riser closets shall be extended 100mm above the finished floor.
5. Sleeves through roofs must be sheet metal flashing with sloping flanges between two layers of roofing material and separate watertight counter flashing on conduit.
6. Sleeves in the trench wall between HT and Transformer room, LT and Transformer room shall be flashed to the wall.

7. Sleeves for the incoming 11 KV cable shall be flashed inside the HT. room and at least 100 mm extended out-side the wall surface.

E. Cutting and Connections
1. All field cuts in conduits shall be square and cut ends shall be reamed and shall have burrs removed.
2. All conduit runs shall terminate in an approved bushing unless the termination is designed to prevent contact between the cable and the end of the conduit. Conduit connections to sheet steel boxes, cabinets and enclosures shall be made with double locknuts.
3. All conduit connections shall be mechanically strong and tight. Connections to couplings, fittings and case boxes, cabinets and enclosures shall be watertight. All rigid metal conduit connections shall be threaded and no running threads shall be permitted.
4. PVC conduit connections shall be made with a solvent cement recommended by the conduit manufacturer.
5. Flexible conduit connections shall be made in accordance with the manufacturer's instructions.
6. Where the surface coating of metal conduit is damaged in handling, cutting or threading, it shall be restored to its original condition.

F. Bends
1. All conduit bends shall be carefully made to prevent distortion of the circular cross section. Field-made bends in conduit shall have an inside radius of not less than nine diameters. Where bends of less than nine diameters are necessary, standard factory elbows shall be used; however, the conduit size chosen shall be such as to permit a cable-bending radius within the factory elbow of at least eight times the cable diameter. Bends in parallel runs shall be concentric. No conduit shall have more than two 90-degree bends or the equivalent thereof between pulling points. Bends shall be made without heating but with an approved bending machine.

G. Cleaning
1. All conduit runs shall be carefully cleaned after installation and inside surfaces shall be free from imperfections likely to damage the cable.
2. Each run shall be snaked with a band to which shall be attached an approved tube cleaner equipped with an approved cylindrical mandrel having a diameter not less than 85 percent of the nominal diameter of the conduit.
3. All conduits and fittings through which the mandrel will not pass shall be removed and replaced by the contractor at his own expense.
4. After cleaning, the ends of all conduit shall be protected with standard caps or plugs to prevent the entrance of water, concrete, debris, or other foreign substance.

H. Fittings
   1. Fittings shall not be used to replace elbows or pull boxes, unless specifically approved by the Engineer.
   2. Expansion and expansion/deflection fittings shall be installed wherever conduits cross structural expansion joints or where long conduit runs are installed. The fittings shall be installed with regard to the temperature so that the full working range of expansion and deflection is available.

3.02 BOXES

A. Where boxes are attached to structural features, fastenings shall be as specified hereinbefore for conduit supports.

B. Boxes shall be installed in readily accessible locations only. Where boxes are installed above suspended ceilings or behind architectural features, access panels of suitable size shall be installed. Access panels shall be marked for location purposes with metal tabs or plastic buttons. Exact location of such boxes shall be confirmed by the Engineer.

C. Unused openings in cast boxes shall be closed with pipe plugs. Unused openings in sheet steel boxes, whether or not they are capped, shall not be permitted.

D. The drawings provided with this specification indicate the approximate position of outlet points only and it shall be the Contractor’s responsibility to mark out and centre on site, the final positions in coordination with the final interior layout and he shall also be responsible for their accuracy.

3.03 CABLE TRUNKING

A. All trunking shall be properly aligned and shall run parallel or at right angles to the walls and the ceiling beams. The erected trunking shall present a smooth and clean appearance and all sections, fittings and covers shall be fixed tightly together. Earth continuity for the trunking system shall be maintained as per EDL regulations.

B. Trunking shall be supported at not more than 1 m intervals. Supports for trunking shall be hot-dip galvanized steel and shall be fastened to building features as specified herein before for conduit supports.

C. The ends of trunking runs shall be closed. Cable/wire entries to the trunking shall be located so as to prevent the entrance of water and debris.

D. All overhead trunking routes shown on the drawing are diagrammatic only and shall be installed to clear the work of other trades. It is particularly important to ensure that all mechanical and electrical services are fully coordinated and

installed to integrated programmes in order to avoid an unsatisfactory trunking installation which if deemed not to have been fully coordinated, shall be removed and relocated at the Contractor's expense.

3.04 FLEXIBLE CONDUITS

A. The interior surface of the flexible conduit shall be free from burrs and sharp edges and each length of flexible conduit shall be provided with a proprietary type of screwed brass male adapter at each end.

B. Flexible steel conduits shall be used with items of equipment which are with drawable or subject to vibration or adjustable, and shall be of such length to allow the necessary full range of withdrawal, adjustment or movement.

C. An insulated protective earthing conductor shall be installed internally and bonded at each end of the conduit.

D. Each length of PVC flexible conduit shall be provided with push fit type male adapters at each end. Earth continuity conductors shall be provided for all conduit runs where flexible conduits are installed.

3.05 CONDUIT IDENTIFICATION DAB'S

A. Use coloured paint DABs on the inside of outlet boxes and paint interior side of the panel covers as they are installed. In ceiling spaces, provide colour to outside of boxes.

3.06 UNDERGROUND DUCT BANKS

A. Build duct banks on undisturbed soil or well compacted granular fill not less than 150mm thick, compacted to 95% of modified Proctor.

B. Excavate and backfill in accordance with the specification.

C. Provide underground pipe bridges to support the duct bank where it crosses previous excavations or other excavations, which from part of this contract.

D. Where additional excavation below the trench bottom is required, slope the walls at 450 along the direction of the trench, and backfill with granular material compacted to 95% of modified Proctor.

E. The trench bottom shall be flat or convex in cross section.

F. Prior to laying ducts, construct a concrete skim slab not less than 50mm thick. Provide base spacers across the skim slab at 1500mm intervals, levelled to the grades indicated for the bottom layer of ducts.

G. Construct a dry well of crushed stone at the low points of the ductbank, and where indicated at manholes. Dry wells shall be pits not smaller than 500mm square x 1200mm deep below the invert elevations of the low points of the duct banks or manholes.

H. Lay ducts with configurations and reinforcing as shown, using plastic or other suitable intermediate spacers to maintain the correct spacing. Maintain spacing between ducts of not less than 40mm horizontally and vertically. Use manufacturer's couplings pulled tight.

I. Install ducts at the elevations and slopes indicated on the drawings, with a uniform grade of not less than 250mm per 100m. The top of any duct bank shall not be less than 700mm below finished grade unless specifically indicated.

J. Provide intermediate spacers at maximum 1500mm centres, and stagger in adjacent layers. Use anchors, ties and trench jacks as required to secure the ducts. Ensure that ducts are not broken, damaged or disturbed during placing of the concrete. Remove weights or wood braces before the concrete has set, and fill the voids.

K. Reinforcing steel and metal ties may encircle all ducts, but shall not encircle any duct or group of ducts in the duct bank.

L. Place concrete carefully and spade continuously to ensure a flow between and under the individual ducts and to provide a solid mass of concrete. Vibrators shall not be used.

M. This Division shall ensure that not less than 75mm of concrete are placed at the top, bottom and sides of the duct bank.

N. Make transpositions, offsets and changes in direction with 5 degrees bend sections or couplings to provide turns of not less than 9m radius.

O. Cut, ream and taper ends of ducts in the field in accordance with the manufacturer's recommendations, so that duct ends are equal to factory-made ends.

P. Provide bell ends at all duct terminations in manholes, trenches or buildings, except where couplings and plugs for future extensions are indicated.

Q. Use rigid aluminum or galvanized steel conduit for bends and for all sections extending above finished grade level. For ducts carrying single conductor cable, use only aluminum conduit.

R. Ensure that a responsible and competent supervisor is present during concreting operations. Advise the Engineer in advance of concreting, so that he may inspect the ducts prior to placing of concrete. Be present during the pour and inspect the complete duct bank before backfilling.

S. Clean ducts thoroughly before laying. During construction securely cap ends of ducts to prevent the entrance of foreign matter.

T. Immediately after placing of concrete, pull through each duct a mandrel not less than 300mm long and of a diameter of 6mm less than the internal diameter of the duct, followed by a stiff bristle brush to remove all sand, earth and other foreign matter. Work the mandrel through the ducts carefully to avoid disturbing or damaging ducts where concrete has not set completely. Pull a stiff bristle brush and a swab to remove water, mud and fine sand through each duct immediately before pulling in cables.

U. Replace or repair to the approval of the Engineer any completed ducts which are defective or unsatisfactory in any way, at no additional cost to the Contract.

V. Ensure that concrete has attained 50% of its specified strength before backfilling.

W. Provide a 6mm nylon cord in each empty duct to facilitate pulling, and a removable plug or cap to seal each end.

SECTION 260536
CABLE TRAYS FOR ELECTRICAL SYSTEM

SECTION 260536
CABLE TRAYS FOR ELECTRICAL SYSTEM

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement and installation of all cable trays and ladders complete with all accessories, fittings etc., as indicated on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents.

1.02 REFERENCES

A. The installations shall comply with the EDL or the following International Standards:
   1. BS 1449 : "Steel Plate, Sheet and Strip"
   2. BS 4360 : "Specification for Weldable Structural Steels"
   3. BS 7671 : "Requirements for Electrical Installations"
   4. BS 2989 : "Hot-Dip Zinc Coated Steel"
   5. BS EN 1461 : "Hot-Dip Galvanized after Manufacture"

1.03 SUBMITTALS

A. Refer to Section 16010 - "Basic Electrical Requirements".

Part 2 - PRODUCTS

2.01 MANUFACTURERS

1. B-Line Systems, Inc (U.S.A.)
2. Niedax (Germany)
3. Swifts (U.K.)
4. OBO Bettermann (Germany)

Or approved equal.

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

2.02 CABLE TRAYS AND LADDERS

A. General
   1. Provide complete cable tray system including all necessary fittings, supports, accessories and hardware, whether or not indicated on the drawings or defined in detail in these specifications.

B. Perforated Trays
   1. Cable trays shall be heavy duty, return flange, perforated type formed from sheet steel to BS 1449 - Part 1 and hot-dip galvanized after fabrication in accordance with BS EN 1461.
   2. Cable trays shall have a minimum thickness of 1.5mm for trays up to 450mm and 2mm for wider trays.
   3. Cable trays shall be assembled complete with couplers, bends, tees, risers, reducers and all other accessories as required and these accessories shall be of the same material, thickness and finish as the trays. Manufacturer's standard accessories shall be used and site fabrication shall only be allowed where special sections are required subject to the approval of the Engineer.
   4. Mushroom head steel roofing bolts and nuts to BS 1494 Part 1 shall be used to fix adjacent sections of cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets to BS 1767; otherwise they shall be bushed or lined.
   5. All hangers, brackets and supports shall be hot-dip galvanized.
   6. All horizontal cable tray run shall be of Perforated Type.
   7. Cable trays shall be provided with a canopy cover when run exposed to open atmospheric conditions i.e. especially sun radiation and rain. This cover shall be fabricated from higher gauge galvanized sheet steel for sound mechanical endurance.
   8. To carry the maximum load of cables with a factor of safety 300%.

C. Ladder Racks

1. Cable ladders shall be H-type made from 2mm mild steel with 3mm coupling plates. Side channels shall be strengthened by reinforcing inserts or other means to increase torsional rigidity. Rungs shall be slotted type and spaced at maximum 300mm. Cable ladders shall be hot-dip galvanized and shall be complete with coupling pieces, bends, tees, reducers, risers, drop-outs, intersections and all other accessories as required and these shall be of the same material, thickness and finish as the ladders.
2. All vertical cable tray run shall be of Ladder Type.

Part 3 - EXECUTION

3.01 CABLE TRAYS/LADDERS

A. Cable trays/ladders less than 3° between fixed points and shall be fixed by support channels and hanger rods, or by cantilever brackets to walls or columns. Fixings shall be disposed at regular intervals not exceeding 1.0 m. Joints shall be positioned as close as practicable to the tray fixing or support. Mid-span joints shall be avoided. All screws bolts and nuts used for fixing shall be zinc plated to BS 1706 - Class B coatings. A minimum clear space of 25 mm shall be maintained between any cable tray or support and the finished wall surface.

B. Cables shall be installed on trays in a single layer except where specified otherwise, leaving 25% of the tray width space for future use. Spacing between two adjacent cables shall be according to EDL Regulations.

C. Cable trays shall be cut only along a line of plain metal and not through perforations. All cut edges of trays shall be prepared with burrs and sharp edges removed prior to installation and any cutting and/or damage made good with rust proofing agent and zinc rich epoxy paint.

D. Where cable trays pass through walls, floors or ceiling, non-combustible, non-metallic fire barriers shall be installed and the whole fireproofed as specified hereinbefore. Where cable trays cross expansion joints in the building, connectors shall be installed with slotted fixing holes to permit movement of 25mm.

E. Cable trays shall be adequately supported to prevent sagging.

F. Cable trays shall be earthed according to EDL Regulations.

3.02 FIELD QUALITY CONTROL

A. Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections.

B. Grounding: Do not use metal trays as earth continuity conductor. Connect trays by flexible tinned copper straps to nearest bare earthing conductor and at maximum 30-m spacing.

C. Anchorage: Test Pullout resistance for toggle bolts and powder-driven threaded studs for each type and size of anchorage material.

   1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales, required for reliable testing.

   2. Obtain Employer's approval before transmitting load to the structure. Test to 90 percent of rated proof load for fastener.

D. Replace malfunctioning units.

3.03 CLEANING

A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

3.04 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensure cable tray is without damage or deterioration at the time of substantial completion.

   1. Repair damaged to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

SECTION 260550
BASIC ELECTRICAL MATERIALS AND METHODS

SECTION 260550
BASIC ELECTRICAL MATERIALS AND METHODS

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic electrical materials and methods requirements. The work of this section is integral with the whole of the contract documents and is not intended to be interpreted outside that context.

Part 2 - PRODUCTS

2.01 MATERIALS

A. All equipment and materials used in the electrical installation work shall be new and of the highest quality to the best modern practices. All materials shall be approved types, supplied by approved manufacturers and shall be fully suitable for use in the climatic conditions stated and on standard frequency and voltage of Lebanon as detailed under Section 260510.

B. All electrical materials and equipment shall comply in all respects (design, properties, qualities, testing, etc.) as a minimum with the latest International Electro technical Commission (I.E.C.) recommendations (as applicable), EDL and Civil Defense Regulations.

C. Should there be any difference between the IEC/BS and this Specification, then the specific requirements of this Specification shall prevail.

D. All materials brought to site for use on the project shall be offered for inspection by the Engineer. The Engineer reserves the right to inspect materials on site at reasonable times and to reject any materials not complying with the specifications.

E. The cost of dismantling and re-erection of the installation occasioned by the removal of the rejected materials shall be at the Contractor's expense.

F. Component parts of similar use and rating shall be interchangeable with each other.

G. All manufactured items shall be the product of manufacturers regularly engaged in producing works of the types specified and be constructed and finished by the same manufacturer.

H. All manufactured items shall be free from imperfections and defects which affect their appearance or may impair their durability or serviceability.

2.02 ORDERING OF MATERIALS

A. The detail of equipment and materials shall include the following:
   1. Full Technical Specifications of equipment including construction, materials, degree of protection, characteristics, curves, diagrams, ratings, dimensions, fixing details, etc.
   2. Relevant sheets of manufacturer's catalogues, specifications, technical data, etc.
   3. Confirmation that equipment and materials offered complies fully with relevant clauses of the Specification and, in case of deviation from the Specification, a schedule of deviations listing all points not conforming to the Specification shall be submitted for the Engineer's approval.
   4. Short circuit study including all components shown on the Schematic Diagrams.

B. Submit at the request of the Engineer, a sample of any equipment or material for further study before approval.

C. Manufacturers specified by name are not relieved of the responsibility for compliance with the Specification.

D. Refer Section 260510 for further requirements.

Part 3 - EXECUTION

3.01 FIXING

A. General
   1. Unless indicated elsewhere in the Specification or on the drawings, the Contractor shall provide and make all fixings to the building for all services included in this Contract.
   2. Coordination with the Client & the supervising engineer is required regarding all electrical equipment from which cables must be disconnected and the equipment removed, to avoid any issues arising from unplanned removal schedule.

B. Raw bolt or similar approval fixings shall be used for heavy loads. Plastic or fiber plugs shall be used for light loads. Other proprietary methods may be specified later in this Specification. The Contractor may offer alternative methods to those specified but the Engineer reserves the right to reject such alternative and call for the use of the specified methods only.

C. All metal fixing devices shall be zinc or cadmium plated, sherardized or hot dipped galvanized including any expansion shields, plugs, nuts, washers, etc., associated with the fixing devices.

D. The Contractor shall carry out any drilling and plumbing for screw fixings of pipe work, raceways, cable trunking, ducting, wiring, conduit fittings, accessories and finishing trims supplied under this Contract.

E. Generally equipment and supports shall be fastened to:
   1. Solid masonry or plastered surfaces by suitable anchors and screws and bolts.
   2. Poured concrete by expandable inserts.
   3. Hollow masonry walls or suspended ceilings by patent retention type fastenings. The Contractor shall establish that there is adequate strength in such hollow material before fixing same.

F. Supports or equipment installed by other trades shall not be used.

G. Purpose made fixing clips and brackets may be necessary in certain areas and the Contractor shall be deemed to be aware of this at the time of tendering and to have included for the supply and fixing of same in this Tender Bid.

H. Details of proposed clips and/or brackets shall be submitted to the Engineer for approval, prior to the manufacture of same being commenced.

I. Holes shall not be drilled in any structural steel work or pre-stressed concrete without first obtaining the approval of the Engineer.

J. Where it is proposed to use cartridge fired bolts for fixing to block work or concrete, approval shall first be obtained from the Engineer. The ruling also applies to stud welded fixing on steel structures.

K. All supports or mountings described above, shall be steel, hot dipped galvanized after fabrication wherever practicable. In cases where the Engineer agrees that it is not practical to provide galvanized steel, supports and mountings shall have at least two coats of rust resistant paint applied.

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEM

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEM

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement and installation of nameplates and labels, wire and cable markers, conduit markers and other accessories required as indicated on the drawings and/or specified herein and in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   1. Name Plates
   2. Labels
   3. Wire and Cable Markers
   4. Conduit Markers
   5. Accessories

1.02 REFERENCES

A. Except as otherwise specified herein, perform work in accordance with specification codes and standards cited therein and to latest applicable addenda and supplements:
   1. UL-224 Requirements.

1.03 SUBMITTALS

A. Refer to Section 16010 - “Basic Electrical Requirements”.

B. Manufacturer’s Instructions: In addition to the above indicate application conditions and limitations of use stipulated by manufacturer. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

Part 2 - PRODUCTS

2.01 NAME PLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Locations:
   1. Each electrical distribution and control equipment enclosure.
   2. Fire alarm cabinets.
   3. Low voltage system cabinet.

C. Letter Size:
   1. Use 5mm letters for identifying individual equipment and loads.
   2. Use 6mm letters for identifying grouped equipment and loads.

D. Labels: Embossed adhesive tape, with 5mm white letters on black background. Use only for identification of individual wall switches and receptacles and low voltage systems outlets.

2.02 WIRE MARKERS

A. Type: Heat shrinkable tubing type wire markers suitable for printing using dot matrix printer and personal computer. Yellow color.

B. Locations: Each conductor at panel board gutters, pull boxes, outlet and junction boxes, and each load connection.

C. Legend: Provide for printing using a dot matrix computer printer.
   1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
   2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings of the equipment manufacturers.

2.03 CABLE MARKERS

A. Type: 6mm minimum size character labels on PVC channels fixed on cables using mounting clips or plastic straps.

B. Location: Fix on cables above 6mm dia. near panel boards, at every floor on risers and at every 15m with minimum one in every room on horizontal runs.

C. Legend: Panel reference and load reference.

Part 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.02 APPLICATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using rivets.

C. Secure nameplate to inside surface of door on panel board that is recessed in finished locations.

D. Identify conduit using field painting under provisions of Section 16010.

E. Paint colored band using two coats of enamel paint on each exposed conduit longer than 10 m.

F. Color:
   1. 400/230 Volt System Power: Grey.
   2. 230V System: Lighting: Grey/Yellow.
   3. Fire Alarm System: Red.

G. All nameplates shall be in English.

3.03 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates to identify all electrical distribution and control equipment, and loads served. Letter Height: 5mm for individual switches and loads served, 5mm for distribution and load equipment identification.

B. Control Panel, Telephone Distribution Points and Frames, Switchboards and Motor Control Centres 6mm; identify equipment designation, identify voltage rating and source.

C. Individual Circuit Breakers, Switches, and Motor Starters in Control Panels, Switchboards, and Motor Centres 5mm; identify circuit and load served, including location.

D. Individual Circuit Breakers, Enclosed Switches, and Motor Starters: 6mm; identify load served.

E. Transformers: Identify equipment designation 6mm; identify primary and secondary voltages, primary source, and secondary load and location.

F. LT switch gear panels, distribution boards, main and sub main panels and similar distribution units shall, unless specified otherwise, be designated in accordance with the reference letters or numbers shown on the Contract Drawings.

G. Labels inscribed with 6mm lettering, red on a white background and the words “DANGER 400 VOLTS”, shall be provided and fixed externally on terminal lids, covers and doors of busbar chambers, link boxes and all equipment which is connected to more than one phase of a low voltage supply.

SECTION 260562
MV SWITCH GEAR CUBICLE (11 KV)

SECTION 260562
MV Switch Gear Cubicle (11 KV)

Part 1 - SCOPE

This specification specifies the minimum technical requirements for design; engineering, manufacturing, inspection, testing and performance of indoor SF6 insulated, intended to be used in 11kV medium voltage system of the project.

Part 2 - APPLICABLE CODES AND STANDARDS

The latest revision / amendments of the following codes and standards shall be applicable for the equipment / materials covered in this specification. In case of conflict, the vendor / manufacturer may propose equipment / materials conforming to one group of industry codes and standards quoted hereunder without jeopardizing the requirements of this specification.

2.01 IEC 62271-100
High voltage alternating-current circuit breakers

2.02 IEC62271-102
Alternating current disconnectors (isolators) and earthing switch.

2.03 IEC 60255
Electric Relays

2.04 IEC60265
High voltage switches

2.05 IEC62271-200
AC metal-enclosed switchgear and control gear for rated voltage above 1kV and up to and including 52kV

2.06 IEC60337
Control switches (low-voltage switching devices for control and auxiliary circuits, including contactor relays).

2.07 IEC 62271-105
High voltage switchgear and control gear alternating current switch-fuse combination

2.08 IEC 62271-105
High-voltage switchgear and control gear alternating current switch-fuse combination

2.09 IEC 60529
Classification of degree of protection provided by enclosures

2.10 IEC60694
Common Specifications for HV switchgear and control gear Standards

2.11 ISO 2063

Metallic coatings – protection of iron and steel against corrosion – metal spraying of Zinc and Aluminum

Part 3 - MANUFACTURER

A. Available Manufacturers for RMU: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to the following:
   1. ABB
   2. Schneider
   3. SIEMENS
   4. Eaton
   5. Or approved equal

B. Available Manufacturers for 11kV load break switch/three way/four way switches: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to the following:
   1. ABB
   2. Schneider

Part 4 - DESIGN AND CONSTRUCTION REQUIREMENTS

4.01 General

The MV switch gear shall be indoor ground mounted and SF6 insulated type. It shall be constructed for operation in service conditions and the degree of protection as required by the project specification. The indoor unit shall be provided with adequate protection for entry of dust to the operating mechanism. The ring main unit shall consist of one of the following configurations as specified in the tender documents:

1. Medium voltage cable entry cubicle with circuit breaker & all necessary protections and accessories, according to manufacturer's type- tested configuration.
2. Three MV cable outlet cells (powering the transformers) with all necessary protection devices and accessories; according to manufacturer's type – tested configuration.

All live parts of the switchgear and busbars assembly shall be grouped together and SF6 gas insulated in a gas-tight stainless steel clamber, and sealed for life.

4.02 System Characteristics

Electrical and mechanical strength of MV switch gear shall be designed to operate in a system to withstand a short circuit current of 25 kA for 1 second or more at 11 kV nominal voltage.

4.03 Current Rating

The continuous current rating of the unit at the project ambient temperature shall be:

1. Ring switches 630A
2. Circuit Breaker 100A

4.04 Ring switch (Load Break Switch)

Ring switch shall be load breaking and fault-making type. Ring switches shall be designed for interrupting full rated current as stated in clause 4.3 above, small inductive or capacitive currents involved in disconnecting of unloaded transformers and cables. It shall be suitable for full fault-making current.
Ring switch shall consist of a moving contact assembly with three positions; 'ON', 'OFF', and 'Earth'. Two independent manual operating mechanisms for ring and earth switches are also acceptable. The design shall prevent simultaneous closing of the main switch contacts and the earth switch contacts. The earth switch contacts shall be designed to close into a fault and shall have the same short circuit capacity as the main contacts.
The switching operation shall be manual by means of an operating handle and independent fast acting operating mechanism. Closing and opening speeds of the switch shall be independent of the speed with which the operating handle is moved.
Ring switch operating mechanism shall have provision for on-site installation (retrofitting) of geared motor mechanism and associated closing and opening coils with necessary contactors for remote and future tele-control operations in the distribution network.

4.05 Tee-Off Circuit Protection

Tee-off circuit protection shall be circuit breaker.

A. Circuit Breaker
The Circuit breaker shall be of fixed type and designed for interrupting full rated fault current (25 kA for 1 second), and full fault making current. The insulation medium shall be SF6 gas and the interruption medium can be either SF6 or vacuum. Opening of the circuit breaker shall be by local manual trip button, by

protective relay circuit and by remote tripping signal. Closing movement charges the opening mechanism, of the circuit breaker. Earthing of tee-off circuit shall be by an off load isolator switch having the same fault make capacity as the Ring switches. Operating mechanism shall be trip free, fast acting and independent of the operator action and shall provide three positions; circuit breaker 'ON', circuit breaker and isolator 'OFF' and earthing switch 'Earth'
Circuit breaker operating mechanism shall have provision for on-site installation (retrofitting) of geared motor mechanism and associated closing and opening coils with necessary contactors for remote and future telecontrol operations in the distribution network.

B. Protective Relay
Self-powered protective relay with over-current and earth fault protection shall be used on tee-off circuits. Double ratio primary current transformers (100/20A, 15VA, 5P10) for protection according to IEC-60044-1 shall be fitted in the circuit breaker panel. General requirements of protective relay are listed in the appendix at the end of this specification.

4.06 Operations

All operating positions shall be on the front of the unit and position of each of the switches shall be displayed on a mimic diagram. Clear indicators showing 'ON', OFF' and 'Earth' positions shall be provided on polycarbonate or metal painted labels not less than 15 mm in height and 1.5 mm thick (sticker type labels are not acceptable). Indicator windows shall not be less than 15 mm in diameter and shall be covered with transparent UV resistant material with adequate mechanical strength.

Indicator	Letters	Background
ON	White	Red
OFF	White	Green
Earth	Black	Yellow

The mechanisms for operating the switches shall be accessible by removing the front plate. The operating handle shall have anti-reflex action and shall be stored at the front of the unit. Common operating handle shall be used for all operations of both ring switches. Operating handle inserts shall have marking as appropriate to avoid inserting the wrong end during switching operations. Physical effort required for operating any mechanism shall not exceed 400 N.
In order to prevent unauthorized access for the operation of ring main unit, operating handle entries for ring switches and trip push button shall have padlocking provision. It shall be suitable for padlocks having 6 mm shackle with 24 mm clearance. The padlocking provision material shall be adequately strong and compatible with the life of ring main unit.

4.07 Cable Testing Facility

Ring main unit shall have a separate test bushings or test plug/probe insertion facility to carry out high voltage tests and current injection tests for the cables terminated on ring switches. Disconnection of cables for testing purposes is not acceptable, any other test facility on cable bushings or terminations shall not be accepted

4.08 Interlocks

A. Interlocks shall be provided to make the following operations impossible:
   1. The operation of a ring switch circuit breaker directly from “ON” to “Earth” or from “Earth” to “ON”.
      The following additional requirements apply if the unit offered has two independent manual operating mechanisms for ring and earth switches:
      a. Operation of the 'Earth ON / Earth OFF' mechanism of earth switch unless the 'ON/OFF' mechanism of ring switch is in the 'OFF' position.
      b. Operation of the 'ON/OFF' mechanism of ring switch unless the 'Earth ON / Earth OFF' mechanism of earth switch is in the 'Earth OFF' position.
   2. Opening of the cable test cover without the associated ring switch circuit breaker being in the 'Earth' position.
   3. Closing ring switch (Load Break Switch) to 'ON' with the test plug / probe inserted and /or the test cover open.
   4. Insertion or withdrawal of the test plugs / probes with the associated switch in any position other than 'Earth' position.
   5. Opening cable termination box without the associated ring switch / tee off in the 'Earth' position.
   6. Switching the ring switch / tee off to ON position without the associated cable termination box cover is properly closed.

4.09 Terminations / Cable Boxes

A. Termination in the Ring switches shall be dry-type inside cable boxes suitable for accepting three core or three single core Copper, XLPE insulated cables of outside diameter of 70-110 mm. Each cable box shall have a bottom plate and cable clamp. Bottom plate shall be in two halves with cable entry hole of 110 mm diameter. Cable clamp shall be detachable semi-circular halves suitable to hold the cable inside the cable box without cable glands.

B. Termination in the circuit breaker shall be dry-type inside cable box suitable for accepting three single core Copper, XLPE insulated cables of outside diameter of 30 mm. The cable box shall have a bottom plate and cable clamp. Bottom plate shall be in two halves with three cable entry holes with rubber bushings.

C. All holes shall be 45 mm diameter for single core cables. Cable clamps shall be detachable semi-circular halves suitable to hold the cables inside the cable box without cable glands.

D. Cable shall be terminated using single hole cable lugs suitable for bolt size of MI6 for ring switches and M12 for tee-off. All necessary bolts, nuts and washers for fixing the cable on the bushings shall be provided with each unit.

E. Bushings for ring switches and tee-off circuit breaker shall be suitable for cable termination by means of bolted type connection with heat/cold shrinkable or pre-molded right angle/straight boots.

F. The clearances in the ring and tee-off cable boxes shall be sufficient for cable termination by heat shrink application.

G. Vertical distance from the top of cable clamp to the centerline of cable bushings shall be suitable for all type of terminations mentioned above.

H. The design of the cable boxes shall be such that the cable box shall allow full access during cable termination. Removal and installation of cable box cover shall be with minimum number of bolts.

4.10 Terminal block

A. Terminal blocks for auxiliary contacts and current injection test for protective relay shall be provided in the tee- off circuit breaker, identified and clearly marked.

B. Terminal blocks for auxiliary contacts for all switches in RAID's to provide digital inputs to any external electronic device in order to present the switches status open/close/earth position of switches.

C. Terminal blocks for SF6Gas Pressure Gage with low pressure indication (Alarm) contacts, (his contact shall provide digital inputs to any external electronic device in order to send an alarm if SF6 Gas is low.

4.11 Enclosure

Ring main unit shall have a tamperproof roof steel enclosure. Enclosure shall be provided with lockable doors, door handles, doorstoppers, hasp for padlocking, ventilation louvers and lifting hooks. The degree of protection shall be IP54 or better as specified in IEC 60529. All panel bolts of enclosure shall be accessible from outside. All nuts, bolts and washers shall be stainless steel or hot dipped galvanized.

4.12 Dimensions

Overall maximum approximate dimensions of the ring main unit shall be in accordance with the manufacturer's requirements an in compliance with international standards.

4.13 Earthing

A ground bar of not less than 25 x 5 mm copper strip shall be provided bolted to the frame. It shall be located so as to facilitate earthing of cable sheaths and earthing devices. In addition, a terminal having M12 stud and nut shall be provided in the back of the panel with clear grounding mark

4.14 Voltage Indicator Lamps / Phase Comparators

Built-in or Push-button type neon voltage indicators shall be provided together with low voltage hot phasing facility on ring switches. The lamps shall be powered by bushing type capacitive dividers.
Internal wiring in cable boxes shall be protected with heat resistant tape/tube, against flame temperatures of gas torch during the cable termination.

4.15 Fault Indicator (FI)

Fault indictor (approved type) with automatic resetting, single-phase AC supply, splitcore type sensor shall be supplied with each unit.
Fault indicator shall be protected inside separate sunshield cover with a mesh front (drawn from the same metal sheet).
FI shall be installed on the left hand side line-feeder. Three-pin plug for testing of FI by primary current injection shall be provided in separate compartment with screwed cover, below the FI housing.
External connectors shall be provided to connect 240VAC reset supply.

4.16 Auxiliaries supply

The MRMU shall not require any external auxiliary AC/DC power supply for operation and control. This power supply shall be obtained from a cast resin insulated voltage transformer connected to bus-bar side. Its secondary output shall be 240 V AC and capacity shall be adequate for spring charging motors, switching operations, status indications, protective relays, necessary contactors for control and monitoring of ring switches and circuit breaker panels and load management devices.

4.17 Load Management system

The unit shall be equipped with a management system that permits the control and monitoring of the consumer's load during normal conditions and peak time.
In normal conditions, and if the consumer exceeds the contacted load (in KVA); the system shall be capable of giving alarm then trips the breaker after a preset time delay.
During peak time, if the consumer exceeds the load previously determined by project, the system shall be capable of giving alarm and tripping / closing the breaker.
The system shall restore the power automatically after the peak period is over without the intervention of any operator.

4.18 SF6 Gas Pressure Indicator & Refilling Provision

Temperature independent gas pressure gauge marked with green (safe) and red (not safe) zones shall be provided. The safe operating zone shall correspond to a temperature range of-10 C to 50 °C.
The unit shall continue to work safely even if the gas pressure inside the tank goes down to the atmospheric pressure.
Refilling/re-pressurizing inlet valve shall be provided and easily accessible for field refilling.

4.19 Over pressure release

In order to ensure maximum personal safety, the MV switch gear cubicle shall be designed to withstand any overpressure due to an internal fault by rupture of a gas escape membrane located at the rear or bottom of the enclosure. The gas shall be led out through a flap in the rear panel to the bottom of the enclosure.

4.20 Nameplate

The MV switch gear cubucle shall be provided with Aluminum /Stainless steel / Brass nameplate showing the following information indelibly marked in Arabic and English:

1. Manufacturer's Name
2. Country of Origin
3. Type / Model
4. Vendor's Name
5. Manufacturer's Serial Number
6. Purchase Order Number of Client
7. Year of Manufacture
8. Voltage Rating kV
9. Current Rating Amps

10.	BIL	kV
11.	Short Circuit Rating / Duration	kA/Sec
12.	Rated Frequency	50Hz
13.	Rated Making Current	kA
14.	Rated Breaking Current	kA
15.	Gross Weight	kg

4.21 Circuit Labels

Ring switches and T-off circuit breaker shall be provided with circuit number plates of dimension 150x50mm without inscription. Plate shall be made of three layer traffolyte material (white /black/white) of 3mm thickness.

4.22 Monograms and Danger Plates

Danger plate shall be provided and installed at the front of the MV-switch gear cubicle using M5 hot dipped galvanized /stainless steel / brass fasteners (oval head rounded neck bolts with nuts and external tooth lock washers) not removable / accessible from the front i.e. without opening the door / front cover.

Part 5 - TESTING AND INSPECTION

A. All equipment shall be type tested at an independent laboratory in accordance with the latest standards and as specified herein and test report shall be submitted for review and approval.

B. The switchgear offered shall meet the type test requirements of the standards listed below:

1. High-voltage switches per IEC 60265
    a. Dielectric Tests
    b. Temperature Rise Tests
    c. Making and Breaking Tests
    d. Peak and Short Circuit Withstand Current Tests
    e. Operation and Mechanical Endurance Tests
    f. Internal arc test certificate
2. Circuit- breaker per IEC 62271-100
    a. Dielectric Tests
    b. Temperature Rise Tests
    c. Measurement of the resistance of the main circuit
    d. Short-time and Peak Withstand Current Tests
    e. Mechanical and Environmental Tests
    f. Making and Breaking Tests
    g. Short-circuit Tests
3. Degree of Protection as per IEC 60529

C. The switchgear offered shall meet the routine test requirements of the standards listed below:

1. High-voltage switches per IEC 60265
    a. Power Frequency Voltage Tests
    b. Voltage Tests on Auxiliary Circuits
    c. Measurement of Resistance of Main Circuit
    d. Operation Tests
    e. Operation and Mechanical Endurance Tests

2. Circuit breaker per IEC 60056
    a. Power Frequency Voltage Tests
    b. Voltage Withstand Tests on Control and Auxiliary Circuits
    c. Measurement of Resistance of Main Circuit
    d. Mechanical Operating Tests

D. The Client reserves the right to visit the factory during manufacture of any or all items covered by this specification, for inspection of material or witness of tests. Accordingly, the manufacturer shall give the Client adequate notice of manufacturing and testing schedule.

E. PACKING AND SHIPMENT
1. MV- switch gear panel shall be delivered ready for installation.
2. MV- switch gear panel shall be individually packed in non-returnable cases
3. MV- switch gear panel shall be delivered with handles, fixing bolts, earthing nuts, leaflet pocket with installation & operating manuals, test plugs and bill of materials for all loose items.

Part 6 - WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. The vendor shall guarantee the MV switch gear against all defects arising from faulty design or workmanship or defective material for two years from the date of duly recorded provisional acceptance of the completed, tested and accepted equipment under the contract. Separate warranty requirements for gas tightness and other components remain applicable within their stated space.

B. Warranty period for gas tightness shall conform clause 5.15.3 of IEC 60694. Vendor / manufacturer shall assume full responsibility for no gas leakage during the service life.

C. In case of gas leak during the service life, all expenses for repairs and replacements shall be borne by vendor / manufacturer.

D. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security

Part 7 - SUBMITTALS

A. Vendor shall complete and return one copy of the attached Technical Data Schedule

B. Vendor shall provide the following with the Quotation

1. Clause by clause compliance with this specification
2. Drawing showing the full constructional detail with dimensions of the MV switch gear panel and all associated accessories
3. Drawings of cable boxes
4. Installation and maintenance instructions of the MV switch gear panel.
5. Comprehensive list of manufacturer's recommended spare parts. The quantities offered should be adequate for the initial 5 years of operation. Firm price and delivery period shall be quoted for each item.
6. Copy of type test report.
7. A certificate from the termination manufacturers that the cable box size in all respect (technical, cable handling and making termination) is suitable for heat and cold shrink and pre-mold terminations
8. Descriptive leaflet and literature of the MV switch gear panel, offered.
9. Checklist of quotation request.
10. List of customers in case of new manufacture / vendor.

C. Vendor shall provide the following after signing of purchase order:
1. Details of manufacturing and testing schedules
2. Routing test reports

SECTION 260569
OIL TYPE TRANSFORMER 11 KV/0.4 KV

SECTION 260569
TRANSFORMER

PART - 1 GENERAL

1.01 DESCRIPTION

A. General:
   1. Furnish all labour, materials, tools, equipment, and services for 20 kV transformer, in accord with provisions of Contract Documents.
   2. Completely coordinate with the work of other trades.
   3. Although such work is not specifically indicated, units and install all supplementary or miscellaneous items, appurtenances and devices Incidental to necessary for a sound, secure and complete installation.

B. Related work specified elsewhere:
   1. General Provisions for Electrical Work.
   2. General requirements.

1.02 QUALITY ASSURANCE

A. All equipment provided under these specifications shall conform to the applicable standards of Authority Electrical Company, (EDL), IEC & ANSI. In case of conflict between the requirements of various parts of these specifications, the requirements of the different parts shall govern to the extent of such conflict in the following sequence: Government regulations, codes and standards, this transformer chapter and the referenced industry codes and standards.

1.03 SUBMITTALS

A. Shop drawings:
   Include all transformer dimensions, ratings, high and low voltage terminal connections, arresters, air switches, assembled transformers outline drawing showing the locations of all accessories.

B. Product data:
   Catalog cuts of devices.

C. Contract closeout information:
   Operating and maintenance data.
   Instructions and maintenance manuals covering installation, operation and maintenance. Basic impulse levels and dielectric tests of the windings
   Losses at no load and at full load.
   Transformer efficiencies.

D. Test Reports:
Submit (6) copies of Standards factory tests performed on each transformer, in accordance with the referenced standards, which include the following:
1. Measurement of insulation and winding resistance
2. Check polarity and vector group
3. No load losses and current & impedance voltage
4. Dielectric tests.
5. Heat run test
6. Impulse test
7. Noise level test

E. Manufacturers
Provide product by ABB (Germany) or any other manufacturer that comply with DIN 42500 Standard.

1.04 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security

PART - 2 PRODUCTS

2.01 TRANSFORMER DESIGN

A. The transformer shall be indoor type with low losses and low noise.
Type: Oil immersed, self cooled (ONAN), hermetically sealed
Phase: Three
Frequency: 50 Hertz.
Voltage: 11 kV - 400-231 V as shown on drawings
Taps: ± 2.5 % and ± 5 % on H.V. side (off load)
Temperature rise - Windings: 55°C average
Noise Level: The average noise level shall not exceed 65 db. when tested as per IEC551
Impedance Voltage:6 % Maximum (IEC - 76)
Insulation Class: "A"
Fluid: Mineral Oil
Protection: IP-23
Coils: Copper

B. Configuration:
The transformer shall be fed from the new MV panel.

C. Rated Capacity:

The transformer shall be capable of operating continuously at its rated input without injurious heating under the variations of voltage and frequency specified and at any ratio. The capacity of transformer shall be 1600 KVA.

2.02 INSULATION LEVEL

A. M.V:
   1. Impulse withstand voltage (BIL) 95 kV
   2. Power frequency withstand voltage 38 kV

B. L.V
   1. Power frequency withstand voltage 3 kV for 1 minute

2.03 DUTY UNDER FAULT CONDITION

All transformers shall be capable of withstanding for two seconds without damage an external short-circuit between phases equivalent to the fault level of the busbars to which they are connected.

The transformer shall be securely wrapped, crated or packed and labeled for safe handling in shipment and to avoid damage or distortion.

Where necessary, temporary bracing shall be used to hoist, lower and skid the transformer into position.

The transformer shall be stored in a secure and dry facility.

The transformer shall equipped with pivot wheels mounted on the channels.

A transformer leakage pit sized for 1600 KVA. Oil transformer shall be installed according to EDL requirements.

2.04 TRANSFORMER ACCESSORIES

A. The transformer(s) shall be equipped with the following accessories:
   1. Drain and filter connection
   2. Pressure vacuum gauge
   3. Dial type thermometer with alarm contacts (No)
   4. Pressure relief device
   5. Lock off facilities on tap changer
   6. Bank earthing
   7. Temperature indicators
   8. Rating plate
   9. Lifting lugs

2.05 INSULATION OIL

The insulation oil used in the transformer shall be mineral oil class 1 in accordance with IEC 296 & SEC. Standards.

2.06 SPARE PARTS

A. For the spare parts quantities required, should be in accordance with government regulations.

B. The transformer shall be provided with the following spare parts:
   1. M.V. Bushing
   2. L.V. Bushing
   3. Oil level indicator
   4. Dial type thermometer

2.07 TESTS

A. Insulation Tests:
   The transformer shall be designed for standard impulse tests and shall receive standard applied and induced potential tests.
   The Contractor shall submit to the Owner for review a certified report of tests on the transformer carried out in accordance with IEC 76.

PART - 3 EXECUTION

3.01 GENERAL

A. Except as may be described in part 2 of this Chapter, refer to the applicable provisions of other Chapters of specification.

B. Installation of transformer shall be according to the manufacturers standard and as per the Authority Electrical Company Standard Code of Practice.

C. Provide labels in Arabic and English Languages.

D. Provide M.V. Danger signs in Arabic and English Languages.

SECTION 262300
LOW-VOLTAGE SWITCHGEAR AND SWITCH BOARDS

SECTION 262300
LOW-VOLTAGE SWITCH GEAR AND SWITH BOARDS

1 - GENERAL

A. ELECTRICAL WORK GENERALLY is to be in accordance with the requirement of the chapter 1 of the Specification.

B. DESCRIPTION OF WORK: main distribution board (s) (MDBs) for low voltage (LV) distribution, ancillary mounting frames, fittings, cables termination accessories and supports.

C. STANDARDS:

1. Switchgear and control gear assembly are to comply, as a minimum, with IEC EN 60439-1 factory Partially Type Tested (PTTA) Assemblies, as indicated in BOQ or drawings.

2. Circuit breakers are to comply with IEC 947- 2 as specified.

3. Other components, where not otherwise specified, are to comply with the relevant IEC standards.

D. DESIGNATIONS: panelboards are designated on the Drawings and in the Schedules as follow:

1. PB or SDB (except where mentioned in the B.O.Q that the SDB shall follow M.D.B. specifications).

2. Final branch circuit panelboards, power panelboards and subdistribution panelboards respectively, for secondary lighting and power distribution with either miniature circuit breaker (MCB) or moulded case circuit breaker (MCCB) protection on subfeeder or branch circuits, as shown on the Drawings.

E. EQUIPMENT DATA: submit data for approval including, but not limited to, the following:

1. Manufacturers' catalogues indicating specific equipment selected.

2. Types of panelboards and circuit breaker characteristics including duties and ratings compensation at and above 40 deg. C ambient conditions and corresponding temperatures within the enclosures.

3. Dimensions of panels and specific contents of each panelboard.

4. Integrated equipment tabulations for coordinated short- circuit series combinations of circuit breakers (cascading and discrimination).

F. TEST AND CERTIFICATES: submit complete certified manufacturer's type and routine test records, in accordance with the Standards

G. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

1. Plans and elevation with indication of built- on equipment, exact dimensions and weights.

2. Arrangement of boards inside rooms allocated, indicating spaces and clearances.

3. Arrangement of equipment inside board.

4. One- line diagram of power system showing current ratings of switchgear and types and locations of protective gear (relays, instruments, CT s, VT s etc.)

5. All protecting device shall show: the Short circuit current value, the voltage drop, the indirect protection function in case of a fault with respect the earthing system.

6. Schematic and elementary diagrams of control circuits.

7. Foundation details, grouting holes, installation details.

8. Arrangement of incoming and outgoing feeders, terminal fittings, instruments, busbar connections etc.

H. TECHNICAL LITERATURE: submit the following for approval prior to placing orders for equipment manufacture:

1. Schedule of circuit breakers application, indicating type, range, features and characteristics, short-circuit ratings, time- current curves etc.

2. Method of setting of protective devices for overload, short- circuit and earth- fault current as coordinated with upstream and downstream systems based on specific coordination curves of protective devices used and specific calculated prospective short- circuit currents at various points.

3. Test methods on site and references.

I. SPARE PARTS: provide manufacturer's recommended spare parts for emergency replacement and/or one year's maintenance including, but not limited to, the followings:

1. One set of fixed and moving contact for every type of replaceable (consumable) contact set.

2. One operating motor and/ or coil for each type of electrically operated circuit breaker.

3. Two sets of each type of indicating lights, fuses, LEDs etc.

J. TOOLS AND INSTRUMENTS: provide tools and instruments required for normal routine inspection and maintenance and testing of circuit breakers and protective devices as appropriate for type of switchgear supplied.

K. All protecting device shall show: the Short circuit current value, the voltage drop, the indirect protection function in case of a fault with respect to the earthing system.

L. ELECTRICAL CLOSETS are to be checked for clearances, spaces and ventilation, for the installation of proposed equipment, prior to starting construction.

M. APPROVED MANUFACTURERS: obtain panelboards from one of the following (or other equal and approved) :

1.	Schneider	(France)
2.	EATON	(EU/USA)
3.	ABB	(Germany/EU)
4.	Siemens – ITE	(Germany/EU)
5.	Legrand	(France/EU)

2 - PRODUCTS AND SYSTEMS

MAIN DISTRIBUTION BOARDS AND ACCESSORIES

2.1. GENERAL REQUIREMENTS

A. GENERALLY: main distribution boards are to be dead- front type, metal enclosed, multi- cubicle, floor mounted, free standing, 600 V class of service switchboards, with fixed or draw- out Switchgear, manually or manually and electrically operated, as shown on the Drawings, with matching vertical sections to from a continuous integral and rigid structure. « Form 4B» as per IEC EN 61439-1 and 2 but with separate sections for outgoing distribution feeders is to applicable on the system construction as indicated on drawings for each panelboard.

B. GENERAL CONSTRUCTIONS: rigidly framed and bolted, with electro-galvanized sheet steel enclosures, minimum thickness 1.5 mm, phosphatized, primed with rust inhibiting primer and finished with thermal polymerized polyester epoxy powder coating, gray color (RAL 7703 or ANSI 61) to approval. Switchgear is to be vermin, dust and rodent proof, IP42 protection to IEC 144 for indoor installations and IP 54 for general service & technical areas installations, with adequate lifting means and base- frames and capable of being moved into position and directly bolted to floor without additional sills. Panel boards shall be thermally studied as indicated below.

C. VENTILATION: compartments are to be ventilated and cooled, where required, by approved methods complying with the Standards. Temperature inside the compartments shall be limited to 40 °C, where ambient temperature is 35 °C.

Where the panel is outdoor mounted and subject to direct sunlight, special measures shall be provided to limit the temperature inside the compartments to 40 °C

D. FASTENINGS: between structural members are to be bolted.

E. EXTENSION: of structure and busbars is to be possible at either end of switchboard

F. ARRANGEMENT: is to permit incoming and outgoing busbars and cables to enter enclosure as indicated on the Drawings and connect at respective terminals without inconvenience to installation or maintenance. **Form 2B is the requested configurations but with separate sections for outgoing distribution feeders.**

G. REMOVING CIRCUIT BREAKERS: suitable arrangements and equipment are to be provided for extracting, lifting and unloading switchgear from enclosures as appropriate for type of switchgear.

H. SPARE AND SPACE POSITIONS are defined as follows:

1. Spare position: fully equipped enclosure with switchgear.

2. Space position: fully equipped enclosure ready to receive switchgear with all necessary accessories (at least 25% of installed switchgear spaie or otherwise as indicated whichever is grater).

I. BUSBARS: Shall be rigid, fully rated and have the same rating of main circuit breaker frame size plus 30%, and braced for a symmetrical rms short- circuit duty equal to or higher than main circuit breaker interrupting duty, for minimum of one second unless otherwise specified or shown on the Drawings. Busbars are to be tinned copper and all connections to be tinned, of sufficient size to limit temperature rise to allowable insulation or equipment temperature ratings, and to maximum 30 °C. Above average ambient temperature of 50 °C outside enclosure. Connections and buswork are to be bolted with copper alloy hardware and are to be accessible for inspection and maintenance.

J. CONNECTIONS: from busbar to switchgear are to be rated to carry full continuous current rating of switchgear frame and are to be insulated.

K. FULL SIZE NEUTRAL: is to be continuous through all sections. Neutral bus is to be insulated and separate from earth bus and connected to it with removable links.

L. EARTH BUS: is to extend full length of board, firmly fixed to each section in accordance with the Regulations and standards, complete with two main earthing lugs (one at each end), and required number of feeder protective earth connectors.

M. SWITCHBOARD TYPE: switchboard(s) are to be of the front accessible wall aligned, with fixed main circuit breaker sections (type and rating as shown in schedules) and fixed group mounted outgoing MCCB distribution section(s), busbars section(s), and feeders' section. All compartments shall have glazed doors except for busbars & cable compartments. If each functional unit is arranged in a separate compartment, a solid door shall be provided for each compartment where the disconnecting element's toggle shall be extended to outside the compartment.

N. FIXED MAIN CIRCUIT BREAKER SECTION: is to individually accommodate main circuit breaker, main cable entry with terminal fitting assembly and metering compartment. Where required an additional cable pull section is to be provided, depending on actual configuration shown on the Drawings. Where placed against a wall, accessibility is to be possible from front and sides or only from front of section.

O. FRONT ACCESSIBLE FIXED, FEEDER MCCB (or ACB) DISTRIBUTION SECTIONS – FEEDERS SECTIONS – BUSBARS SECTION: are to rear align with main section(s) and be of uniform depth, with all devices removable from the front and mounted on a panelboard type base. Construction is to allow all connections and maintenance to be made without rear access. Cables are to be accommodated in extra wide vertical section(s). Sides, top and rear are to be covered with removable screw- on plates having

formed edges all around. Front plates are to be sectionalized and removable, covered by times, and secured by self-tapping screws. If Plexiglas (or any other material) is used for segregation, it has to be fire retardant. Busbars are to be accommodated in separate horizontal and vertical sections.

The electrical link from the busbars to each distribution MCCB (or ACB) shall be by flexible insulated busbars unless the MCCB or ACB's frame size is greater than 600 Amperes. In this case, the electrical link shall be rigid busbars.

2.2 Air Circuit Breakers (ACB)

- Unless indicated otherwise on the drawings, all breakers rated above 800 A as well as the incoming breakers shall be Air Circuit Breaker (ACB) type, withdrawable or fixed, Motorized or Non-Motorized, 3 or 4 poles, as indicated on drawings, with the following features:

    1. Air circuit breakers shall include:
        a. Safety shutter (for withdrawable type)
        b. 4 auxiliary contacts – ON/OFF signaling status
        c. 2 Alarm auxiliary contacts.

    2. Trip unit for ACB shall include LT, ST, INST protection
    3. The trip units shall preferable include digital LCD screen, that continuously monitor voltage, current, frequency, power factor, KVA, KW ….. And be equipped to communicate with external hardware and software for the purpose of monitoring and measurement.

2.3 MOULDED CASE CIRCUIT BREAKERS (MCCBs)

A. MCCBs GENERALLY are to be thermal- magnetic type for ratings below 400 A frame size, unless otherwise shown on the Drawings. MCCBs 400 A and larger are to be electronic solid- state trip type. All circuit breakers are to be 4 poles (protected) unless otherwise shown on drawings.

B. CONSTRUCTION: totally enclosed, moulded case, constructed from high quality, high temperature resistant, tropicalized, moulded insulating materials, for normal operation at 70 °C within enclosures, to approved standards, provided with quick-break, trip- free switching mechanism manually operated by front toggle type handle and automatically tripped under over-current and short circuits conditions. Multi-pole breakers are to have common integral trip bar for simultaneous operation of all poles. Contacts are to be non-construction. Cables terminals are to be solder-less anti-turn box lug or clamp type with set screws suitable for copper or aluminum cables.

C. THERMAL MAGNETIC CIRCUIT BREAKERS: are to include, on each pole, a bimetallic inverse time-delay over-current trip element for small overloads and instantaneous magnetic over-current trip elements for operation under short- circuit conditions. Circuit breakers 250 A frame size or where shown on drawings, shall have adjustable short time trips (I_m).

D. THERMAL OVERCURRENT TRIPS: are to be compensated to allow for ambient temperature higher at breaker than at protected circuit or device. Compensation is to be applicable between 25 and 50 °C. In case of adjustable thermal settings, range of adjustment is not to exceed maximum trip rating shown on the Drawings.

E. ELECTRONIC TRIP CIRCUIT BREAKERS: unless otherwise specified on drawings, electronic trip circuit breakers are to have solid state trip units with long time delay setting range at least between 0.4 and 1.0 times maximum trip rating, short time delay range 2 to 10 times maximum trip rating with maximum clearing time of 0.2 seconds, and instantaneous protection adjustable from 2 to 11 times continuous rating (fixed at 11 times continuous rating for circuit breakers 250A frame and lower). Solid state trip units are to be insensitive to changes in ambient temperature between -20 and + 55 °C. Earth fault protection is to be built into trip unit where specified, and is to be adjustable between 0.2 and 0.6 normal phase current pick- up. Maximum adjustable time delay of 0.4 seconds, and is to be suitable for connection to external current sensor. Push- to- trip button is to be provided on cover for testing the trip unit.

F. TRIPPED POSITION: when tripped automatically by over-current condition, operating mechanism of circuit breaker is to assume an intermediate position clearly indicated by the handle between on and off positions.

G. INTERCHANGEABLE TRIPS: circuit breakers 100 A to 630 A frame size are to have interchangeable thermal and electronic trip units.

H. SEALING: non- interchangeable trip circuit breakers are to have sealed covers. Circuit breakers with interchangeable trips are to have trip unit covers sealed to prevent tampering.

I. CIRCUIT BREAKER RATINGS: are to be non-current limiting, fully rated (100%) with continuous duty at site conditions, and with frame size and interrupting capacity to IEC 947- 2, sequence II (rated service short- circuit) breaking capacity, and maximum trip rating as shown on the Drawings. Interrupting capacities at specified voltage and frequency are to meet IEC 947- 2 test sequence I, II and III for circuit breakers of utilization category A for circuit breakers with frame size 630 A and less.

J. ACCESSORIES: circuit breaker design is to allow addition of electrical operator, control and interlocking functions, under- voltage release, shunt- trip coils, alarm and auxiliary switches, padlocking devices, key-lock devices and the like. Such accessories are to be provided where shown on the Drawings.

2.4 DIGITAL POWER METERING INSTRUMENTS

A. GENERALLY: Power meters shall combine the following functions in a signal unit:
   1. True RMS measurements up to the 31st harmonic for voltage, current, frequency, power and power factor.
   2. Measurement of power quality, i.e. the level of harmonic distortion (THD)

in voltage and current.
3. Metering of active and reactive energy.
4. Indication and control via two output relays that can be assigned to power or power factor to trip alarms or initiate load shedding.
5. Transmittal of all the measurements indicated below to the BMS system.

B. MEASUREMENTS
1. Phase to neutral voltages (V1N, V2N, V3N): 115 to 500 VAC, ± 1% accuracy.
2. Phase to phase voltages (U_{12}, U_{23}, U_{31}): 115 to 500 VAV, ± 1% accuracy.
3. Currents (I_1, I_2, I_3 and I_N): 15 to 2500 A, ± 1% accuracy.
4. Maximum Current.
5. Frequency: 45 to 65 H_Z, ± 0,02% accuracy.
6. Power factor: ± 1,5% accuracy.
7. Active Power: ± 1,5 accuracy.
8. Reactive Power: ± 1,5% accuracy.
9. Apparent Power: ± 1,5% accuracy.
10. Active energy consumed.
11. Reactive energy consumed.
12. Apparent energy consumed.
13. Reset of meters (including maximeter).
14. Harmonic distortion of currents I_1, I_2, I_3 and I_N: ± 1% accuracy.
15. Harmonic distortion of voltages V_{1N}, V_{2N}, V_{3N}, U_{12}, U_{23} and U_{31}: ± 1% accuracy.
16. Assignment of output relays for power (active, reactive, apparent), demand power and power factor.
17. Measurement shall be available on the front panel of the power meter, by an LCD screen.

C. Mechanical Characteristics:
1. Degree of protection IP 40.
2. Vibrations F_C test: 2 to 13,2 H_Z-1 mm and 13,2 to 100 H_Z-0,7 g.
3. Operating temperature: -20 to +55 °C.

2.4. WIRING

A. ARRANGEMENT: wiring is to be modularly and neatly arranged on master terminal boards with suitable numbering strips and appropriate cartridge type fuses where required. Terminal boards shall be WAGO or approved equal.

B. CONNECTIONS: are to be made at front of terminal boards and with no live metal exposed.

C. METAL CASES: of instruments, control switches, relays etc. Are to be connected, by bare copper conductors not less than 2.5 mm^2 section, to nearest earthing bar.

D. CONTROL WIRING: copper. PVC insulated 85 °C, 600 V grade, and PVC sheathed for multi- core cables running from the control terminal blocks to outside the panel. Finely stranded copper conductor, PVC insulated, 85°C 600V grade insulated conductors are to be used inside the panel.

E. FERRULES: wires are to be fitted with numbered ferrules of approved type at each termination.

2.5 MISCELLANEOUS

A. SCHEMATIC AND WIRING DIAGRAM: is to be provided suitably located within each cubicle.

3 - FIELD AND INSTALLATION WORK

3.1 INSTALLATION

A. EQUIPMENT BASES: ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and equipment manufacturers drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

B. CABLE TRENCHES: ensure that trench construction and covers provided for installation of power and control cables are in accordance with approved shop and construction drawings.

C. BUILT- IN ITEMS: ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which are to be built into concrete foundations, bases, cable trenches or building structure are provided as and when required and that they are properly installed.

D. EQUIPMENT: install on concrete bases etc., and assemble completely plumb and level, before grouting in holding- down bolts.

E. SUPPORTS AND TERMINATION'S: install all incoming and outgoing cable supports, cables ends and termination fittings required for power and control cables.

F. RELAYS: set in accordance with manufacture's instructions and in accordance with an approved scheme.

G. MAKE GOOD: damaged painted surfaces, clean and apply rustinhibiting prime coat and two finishing coats of approved enamel upon delivery of equipment to site, or as required by the Engineer.

3.2 INSPECTION AND TESTS ON SITE

A. EQUIPMENT: inspect- equipment upon delivery to site and report any damage to the Engineer.

B. SWITCHGEAR: inspect and check switchgear for completeness, component ratings, types, sizes, and wiring connections. Check phasing of busbars, contacts and clearances.

C. TEST: after installation and before hand over, carry out all tests required by the governing codes and any other tests the Engineer may require to check compliance of installation with the Specification, including insulation resistance tests and operational tests.

D. MAIN AND CONTROL CIRCUITS: using 1000 V megger (2000 Megohm range), check insulation resistance between phases, between phases and earth/ enclosure and between neutral and earth.

E. PRIMARY INJECTION TESTS: provide portable test equipment to test time-delay characteristics of circuit breakers by simulating an overload or faults condition. Measure and record all test results and ambient conditions and compare with manufacturer's data.

F. INSTANTANEOUS TRIP ELEMENTS: test by high current primary injection, using high- current primary injection test- sets and report all readings.

G. ROUTINE TEST ON SITE: are to be carried out on every main distribution board in accordance with the Standard specified (IEC 439) for FBAs (feeder branch assembly) assembled from standardized components outside the works of the manufacturer. Routine tests are also to be carried out on every FBA, delivered to site, if requested by the Engineer.

SECTION 262726
WIRING DEVICES

SECTION 262726
WIRING DEVICES

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement, installation, testing and commissioning of all wiring devices and lighting accessories hospital grade antibacterial as required, specified herein and in accordance with the Contract Documents. Work includes but is not limited to the following:
   1. Switches
   2. Socket Outlets
   3. Connection Units
   4. Ceiling Roses

1.02 REFERENCES

A. The installation shall comply with the local or the following International Standards, including all amendments:
   1. BS 67 : "Ceiling Roses".
   2. BS 3676 : "Specification for Switches for Domestic and Similar Purposes (for fixed or portable mounting)".
   3. BS 4662 : "Specification for Boxes for the Enclosure of Electrical Accessories".
   4. BS 5419 : "Specification for Air-break Switches, Air-break Disconnector, Air break Switch Disconnector and Fuse Combination Units for Voltages up to and including 1000V a. c. and 1200V d.c.".
   5. BS 5733 : "Specification for General Requirements for Electrical Accessories".
   6. BS 7671 : "Requirements for Electrical Installations".
   7. BS 1363 : "1984 13A Fused Plugs Switched and Unswitched Socket Outlets and Boxes".
   8. BS 546 : "Two Pole and Earthing Pin Plugs, Socket Outlets".
   9. BS4343 : "Industrial Plugs, Socket Outlets and Couplers for AC and DC Supplies".

1.03 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A.

1. Legrand - France
2. Merten - Germany
3. Hager – Germany
4. Approved Equal

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

C. All switches, sockets, junction boxes etc. shall be of hospital grade whether specifically mentioned or not.

2.02 WIRING DEVICES

SWITCH:

Single pole flush type switch 10-16A-250V~. the mechanism must contain block-shaped silver contacts (alloy containing 90% silver at least) arranged in the form of a cross, and cage terminals with screws, which cannot be lost. The flush type bridge must have a metal thickness of 1mm and must be bright galvanized on all sides. It must contain lead slots on both the horizontal and vertical spindle for screw-fixing on flush mounting boxes. The mechanism, mounting plate, rocker and cover plate assembly must have protection value IP21. All parts must be self-extinguishing and halogen-free. Mechanism recess depth: 25mm. assembly projection height: 8mm on average. CE, CEBEC, KEMA, VDE, ~VE, USE and ESS approved.

LIGHTING SWITCHES:

A. Switches shall be mounted on the latch side at all hinged doors in suitable outlet boxes in the wall or partitions except where noted on the contract drawings.

B. Switches shall be rated 10-16 amperes, 220 volts ac.

C. Switches shall be rocker operated mounted with the operating handle in the upward position when in the “ON” position unless otherwise directed by the engineer.

D. Switches shall interrupt the hot wire or hot and neutral simultaneously as applicable.

Switches shall be quick-make, quick-break, with silver alloy contacts, turn-ons and spring assembly lubricated for the life of the switch neoprene bumpers.

E. Switches shall be 250 volt ac only rated with number of gangs, poles and amp ratings as indicated on the drawings, to VDE.

F. Switches shall be fully rated for LED lamp loads.

G. Lighting switches in general shall be 10 amp rated as a minimum.

H. Lighting switches marked on drawings with W, watertight notation shall be weatherproof, IP55, degree of protection, similar to Legrand Plexo range of approved equal.

I. Switches in hazardous area in which flammable gases or vapors may occur shall be in accordance with IEC-79 and VDE-0711.

J. All switches shall have earth connection.

SOCKETS OUTLETS:

1. Sockets outlets for general use shall be simplex or duplex, 3 wire, 16 ampere, 220 volt.

   The normal sockets shall be white or as approved by the Engineer.

   16-amp sockets with W notation on drawings (watertight) shall subject to the approval of the Engineer.

2. Dual double pole flush mounting socket-outlet 10A=/16A~ 250V. the socket-outlet must contain contact buses with a large contact area that do not support on the base for clamping the wires and screw clamps with screws which cannot be lost. The pole terminals must contain up to 4 x 4 mm2 wire. The flush type bridge must have a metal thickness of 1mm and must be bright galvanized on all sides. It must contain lead slots on both the horizontal and vertical spindle for screw-fixing on flush mounting boxes. In addition to this the flush type bridge must contain dovetails which allow an easy horizontal mounting of several socket-outlets. The socket-outlet, central plate and cover plate assembly must have protection value IP21. All parts must be self-extinguishing and halogen-free. Mechanism recess depth: 21mm. Assembly projection height: 8mm on average. CEBEC, KEMA, USE, NF and AENOR approved.

3. The double pole switch cover plate shall be metal clad and flex outlet cover plate shall be white moulded type engraved or to match with adjacent finishes.

4. Wet-Location, Waterproof Cover Plates: NEMA 250, complying with Type 3R weather.

2.03 LIGHTING ACCESSORIES

A. Lighting Control

1. General

   Provide complete lighting control system including direct switching control, as detailed and indicated on the drawings and specified hereinafter.

2. Direct Switching

   a. Locally installed on-off switches controlling the lighting for a particular room by means of direct connection/disconnection of lighting circuits.

   b. Switches in general shall be flush mounted in walls inside PVC or galvanized stamped steel boxes at a height of 1200mm above finished floor level, unless otherwise warranted for coordination and indicated on the Drawings. Switch cover plates shall be approved by the Engineer. Finishes for important areas shall be as directed by Engineer. Terminals shall be of the screw type or solder less pressure type having suitable conductor release arrangement. Where two switches are located in the same position and same phase, they shall be installed in one box and covered by a multi-gang cover plate. They shall be limited to two only.

   c. Switches when mounted externally to JB and connection units, shall be double pole, with indication lamps and engraved.

   d. Switches installed in plant mechanical rooms, kitchens, parking and outdoor areas shall be splash proof type with seal grid switch enclosures and fitted with neon pilot lamp. The switches shall comply to the degree of protection IP44.

   e. Switch cover plates shall be provided with earthing terminal lugs.

   f. Double pole (DP) switches are rated minimum 20A and shall be provided with inbuilt pilot lamp.

3. Photocell Controls

   a. Provide a photocell sensor and control unit for control of external lighting, with wiring arrangement as indicated on the respective Drawing.

   b. The photocell sensor shall comply with BS 5972 and shall be complete with rotary locking action NEMA standard three pin sockets. The sensor head shall comprise an encapsulated cadmium sulphide cell with computerized calibration and minimum 5 amp inductive rated S.P. switch. The sensor shall have a conical self cleaning translucent enclosure which shall not discolour or crack in direct sunlight and ambient temperature of 60° C. The switching differential shall be within the ratio 1 to 1.5.

   c. External lighting sensor and control unit ‘switch on’ arrangement shall be field adjustable between 40 and 1500 Lux.

   d. The sensor socket shall be all insulated construction with shrouded screws complying with BS finger test. No electrical contact shall be made until the sensor is plugged in and rotated to its locked position. The socket shall be supplied complete with minimum 12mm thick neoprene gasket and shall be

mounted within IP 65 weatherproof adaptable box complete with purpose made bracket for wall mounting in horizontal position.

e. The control unit shall incorporate a 'MANUAL-OFF-AUTOMATIC' key switch on the enclosure front cover to provide override control of the photocell at main entrance.

FIELD QUALITY CONTROL:

Provide checking, adjusting and testing operations on the wiring devices installation including the following:

Check: all wire terminals shall be checked to assure tight connections, electrical continuity and for short circuit.

Operate each device at least 6 times. All wiring services shall be clean before energizing.

- Adjust: Adjust wiring devices to operate in the indicated and required sequence.
- Testing: The tests shall be performed to detect wrong connections, short circuits, continuity.

Test wiring devised for proper polarity and ground continuity.

Perform the following field tests and inspections and prepare test reports.

- After installing wiring devise and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements
- Test RCD operation with both local and remote fault simulations according to manufacturer's written instructions.

Control Device Test Conditions:
Test Voltage: 220V, 50Hz gradual for one minute.
Insulation resistance tested at 500V: > 5MΩ.

Part 3 - EXECUTION

3.01 INSTALLATION

A. Wiring devices shall not be installed until after wiring and decorations are completed.

B. Wiring devices shall be installed in boxes which are free from excess building materials and debris.

C. Plaster surfaces that are broken or incomplete shall be repaired so there will be no gaps or holes at the edge of the front plate of the accessory.

D. Installation shall be in accordance with the NEC and as shown as on the drawings.

E. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.

F. Outlet boxes for light switches shall be mounted on the strike side of doors.

G. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. 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.

H. 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. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.

I. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

J. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, 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.

3.02 SOCKET OUTLETS

A. Socket outlets shall be installed at a height of 1200mm above finished floor in mechanical and electrical areas and 300mm for other areas except as otherwise specified or indicated on the drawings or as approved by the Engineer.

3.03 LIGHTING CONTROL DEVICES

A. Lighting switches and push buttons shall be installed at a height of 1200mm above finished floors except as otherwise specified or indicated on the drawings or as approved by the Engineer.

3.04 REMOVAL OF ACCESSORIES FOR PAINTING

A. Allow for removal of switch-plates, lighting points, fittings, socket-outlets, etc., to permit painting of surfaces and refix.

3.05 GENERAL

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.

C. Outlet boxes for light switches shall be mounted on the strike side of doors.

D. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. 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.

E. 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 the above items with other trades. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.

F. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

G. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, 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.

H. Test RCD for tripping values specified in BS.

SECTION 263213
ENGINE GENERATOR

SECTION 263213
ENGINE GENERATOR

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, procurement, installation, testing and commissioning of the complete emergency power generation system comprised of diesel engine driven generator sets and appurtenances as indicated on the drawings and/or specified herein and in accordance with the Contract Documents.

B. Related Sections:

1. Section 260500 - Common Work Results for Electrical
2. Section 260510 - Basic Electrical Requirements
3. Section 260550 - Basic Electrical Materials and Methods
4. Section 260526 - Grounding and Bonding
5. Section 260553 - Identification for Electrical System
6. Section 260519 - Low Voltage Conductors and Cables
7. Section 260533 - Raceway and Boxes
8. Section 260536 - Cable Trays
9. Section 260562 - MV Switch Gear, 11KV
10. Section 260569 - Medium Low Voltage Oil Transformer
11. Section 262726 - Wiring Devices
12. Section 263213 - Engine Generators
13. Section 262300 - Low Voltage Switchgear and Switchboards
14. Section 265100 - Lighting
15. Section 283133 - Fire Alarm Systems

1.02 REFERENCE

A. British Standard Institute (BSI):

1. BS 5514: Reciprocating Internal Combustion Engines, Performance.

B. International for Standardization Organization:

1. ISO 3046: Reciprocating Internal Construction Engines, Performance.
2. ISO 8528: Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets.

1.03 SYSTEM DESCRIPTION

A. Design Performance

1. The normal mode of system operation shall provide for unattended transfer of load and load control for the emergency power system. Upon receiving a signal from a voltage sensing relay in any of the ATS indicating failure of normal power from EDL or solar system, the system control unit will signal generator to start. The generating set to reach approximately 90% of rated frequency and voltage signals its start sensor. This start sensor then initiates a closing signal to ATS, connecting this generating set to the emergency supply.
2. After normal power has been restored to the transfer switch and after the time delay on retransfer has expired, the transfer switch shall return to normal

power. After the time delay on stop has expired, the set shall then shut down simultaneously.

3. The emergency power system shall have the capability of being manually operated. The generator set may be started by engine control switch located on the respective engine control unit. Once started and stable, the generator may be manually connected to the emergency bus through the generator circuit breaker and manual change over system.
4. The generator control unit shall be equipped with a generator breaker control switch, engine speed adjusting potentiometer and a generator voltage adjust rheostat.

B. Design Requirements
   1. In addition to provision of equipment the Contractor shall provide the services of the manufacturer or his authorized agent to advise upon the provision and installation of Engine-Generator Set, fuel tanks and piping, storage tank, fuel pumps, generator control panel automatic transfer switches, shock isolators and exhaust blast valves, etc.
   2. Each generator set shall be monitored via a monitoring panel located in the control room.

1.04 SUBMITTALS

A. Product Data: Submit to the Engineer for information only in accordance with the requirements of the Contract Documents copies of manufacturer's data on generator system and components.

B. Shop drawings: Submit to the Engineer dimensioned drawings of generator units and accessories including but not limited to automatic transfer switches, shock isolators, fuel line piping, remote start, stop stations and instruments, showing accurately scaled generator set layout and relationship to associated equipment, and connections to remote equipment. Confirm the size of the room is adequate for the proposed emergency power generation system equipment and panels.

C. Provide working drawings, spare parts, special tools, operation and maintenance manuals, as-built drawings, testing and commissioning as specified in Section 16010.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: The Diesel Generator installer shall meet the objective qualification requirements stated in the tender documents and shall provide documented manufacturer or authorized – agent support for installation, commissioning, warranty and local maintenance. Eligibility shall not be restricted to a closed list unless the restriction is legally justified and expressly stated in the tender documents before tender publications, and shall be one of the specified D/G Subcontractors. He shall be normally an agent representing one or more of the approved makes of D/G sets and shall have previous experience in D/G installation work.

1.06 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Special Project Warranty: Submit a warranty executed by the Contractor, Installer and Manufacturer agreeing to repair or replace components or entire generators which fail in materials or workmanship within the specified warranty period. Failure includes but is not necessarily limited to mechanical and electrical breakdown, failure and deterioration of metals, components and other materials beyond normal wear and tear.

B. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A. Generators:
   1. Caterpillar Tractor Co. (USA)
   2. Cummins Power Generator (UK)
   3. F.G. Wilson, U.K.
   4. Volvo (EU)
   5. Approved equal

B. Alternator Brand:
   1. Stamfard
   2. Leroy Somer
   3. Caterpillar.
   4. Approved Equal

C. The products and manufacturers specified herein are specified for the purpose of establishing minimum quality standards. Products equal in quality to, or better than those specified, will be acceptable. The decision of acceptability rests with the Engineer.

2.02 GENERAL

A. The diesel generator sets shall be from a reputable manufacturer and supplied by one supplier approved by the Engineer and having a local Agent. The set shall be factory assembled and tested by the engine manufacturer and shipped to the job site by his authorized dealer.

B. Provide complete operating emergency generating system, including diesel engines, generators, control panels, batteries, starting motors, radiators, exhaust piping, silencer, fuel storage tank, fuel daily tanks, fuel pumps, fuel control panel and piping and all other accessories as specified.

C. The sets shall be of rugged reliable design suitable for long trouble free service and from an approved manufacturer with service facilities and spare parts stock.

D. All materials and equipment shall comply with relevant IEC and BS Specifications as regards quality of materials, performance and proving tests.

E. The set shall be capable of starting the largest motor connected to the same emergency panel when all other emergency motors and loads are on. Submit calculation to prove the above.

F. The engine and generator shall be properly aligned and mounted on a common steel base through resilient mountings to prevent vibrations. The whole sets shall be fixed on concrete slabs through a suitable vibration isolation system.

G. The vibration isolation system shall be as per manufacturer's recommendation and consist of inertia base and spring isolator of 1.5 inch minimum deflection.

H. All exposed moving parts of the engine and alternator shall be fully guarded so as to prevent accidental contact with guards securely fixed but arranged so as to be readily removable for inspection and maintenance.

I. The generator sets in shelters shall be designed to withstand severe shock and mounted on special shock isolators. Special shock isolators shall be supplied by the generator supplier and approved by Civil Defense.

J. The sound proof canopy for each generator must be installed on site, such that its length does not exceed 4.8m, while ensuring it is capable of providing the required nose level.

K. The generator specialist contractor, must ensure the required noise level is met by insulating the room in addition to providing the canopy.

L. The controller shall have full communication protocol as RS 232, RS 482 and GSM with very high sampling rate.

2.03 ENGINE

A. The engine shall be direct injection, four strokes, 1500 RPM, naturally aspirated or turbo charged after cooled diesel engine prime rated at site conditions to provide rated output power for the generator. Rating shall be prime rated ambient conditions, net electrical output with 10% overload power in accordance with ISO 3046 and BS 5514.

B. The engine shall be with built-in air cooled radiator and shall include air cleaner/air filter, fuel and lubricating oil filters, water pump, fuel and lubricating oil pumps, oil cooler, governor, flywheel, starter motor, tachometer, service hour counter, oil and water gauges, safety devices and all other accessories. The air cleaner/filter shall be of heavy duty with safety elements. The fuel filters shall be suitable for preventing all particles of 10 micron size or larger from passing.

C. A pressure type lubricating system with gear type oil pump and filters shall be fitted to the engine. A graduated dipstick shall be provided, located in an accessible position.

D. A heat-exchanger must be fitted in the cooling-water circuit for cooling the lubricating-oil and shall be capable of keeping lubricating-oil temperature within safe limits at all conditions of load requirements at worst climatic conditions. The drain connection for draining of sump oil must be brought on side of the generator base. Method of lubrication should be fully described in the offer. It is preferable that the camshaft-bearing lubrication be directly fed from the lubricating-oil pump and not through the main bearing.

E. The governor shall be electronic type isochronous frequency regulation from no load to rated load, speed sensing and to respond to load changes which minimize speed dip and recovery time. The governor shall be capable of remote speed adjustment. The governor system shall include the following:
   1. Magnetic pick-up.
   2. Proportional actuators.
   3. Oil pressure switch.
   4. Control box.

F. The engine shall run steadily at any load at its rated speed. Changes in speed shall comply with B.S. 5514 or ISO 3046 for Class A2 governor. The engine shall have safety devices for stopping the engine and giving alarm in cases of high water temperature, low oil pressure and over speed.

G. Drain plugs and cocks for oil, water and fuel shall be provided in readily accessible locations.

H. Emergency relief diaphragms shall be provided to obviate danger of crank case explosions, fitted on the side remote from the generator.

I. Engine mounted wiring shall be of high heat resistant cables properly fixed and protected and terminating in a common terminal box mounted on the engine.

J. The diesel engine shall be de-rated according to BS 5514 for operation climatic condition (Altitude: 500 ft above sea level, temperature: 55°C, RH: 50%.) Engine manufacturer’s certificate for engine derivation shall be submitted to the Engineer for approval.

K. Noise attenuation must be 65 to 70 dB 3 meter from air intake and outlet louvers on free field site.

2.04 COOLING SYSTEM

A. The cooling system of the engine shall be by means of water jacket. The radiator shall be heavy duty tropical design with mechanically driven fan of sufficient capacity to maintain safe operation at the site worst climatic conditions. Coils shall be of copper alloy tubing with copper fins.

B. The radiator shall be provided with fan guard and shall be connected by flexible connections to engine water pipes.

C. A thermostatically controlled valve shall be provided in the cooling system to assist rapid heating up of the water in the engine jacket when starting from cold. A thermostatically controlled electric heater, suitable for connection to mains supply

shall be located in the cooling water circuit with 'ON/OFF' switch in the control panel. The heater shall be capable of maintaining the whole of the cooling water at a temperature of 20°C with an ambient temperature of 0°C. Indicating lamps in the control panel shall indicate when heater is 'ON'. The heater shall be switched off automatically when the engine starts and switched 'ON' when it stops. The heater shall be connected through HRC fuses. Heaters shall be easily removable for replacement.

2.05 VENTILATION SYSTEM (REFER TO MECHANICAL SPECS)

2.06 EXHAUST (REFER TO MECHANICAL SPECS)

2.07 STARTING AND BATTERIES

A. The engine of the Emergency Generator shall be started by a 24V, D.C. axial type starting motor automatically engaging with engine flywheel and positively disengaging on engine start. The engine starting control equipment shall be arranged to disconnect the battery charger to prevent it from being overloaded during starting. The starter motor shall be of adequate power for its duty.

B. Batteries for starting shall be of the lithium iron phosphate (life P04) type, 24V, heavy duty diesel starting type and of sufficient capacity to provide continuous cranking of 1.5 minute duration without recharging and able to provide 3 successive starts in 60/90 seconds.

C. The batteries shall be installed in robust containers complete with cables and clamp.

D. The battery charging shall be provided from a suitable three-phase full wave rectification static-charger with auto trickle-charge enclosed in an adequately ventilated sheet steel case and incorporated within the control panel with its associated instruments and controls mounted on front of panel.

E. The charger shall be complete with all necessary relays, cutouts, controls, switches and instruments for automatic charging of batteries. The charger shall automatically control the charging rate to suit state of battery thus charging at high rate following a period of use of battery and, when battery nearly fully charged, reverting to trickle charging automatically. The AC main healthy and on shall be with visual indicator lamp.

F. An ammeter and voltmeter in the control panel shall indicate the state of the battery and its charging rate.

2.08 FUEL SUPPLY (REFER TO MECHANICAL SPECS)

2.09 GENERATORS

A. The generators shall be 3 phase, 4 wire, 415/240 V, 50 Hz of rating as shown on the drawings, continuously rated to BS 5000 Part 99, tropically insulated with

Class F insulation, rotating field, brushless, self exciting with silicon rectifiers, self regulating within ± 2.0% under all conditions.

B. The generators shall be direct coupled to the diesel engines, the whole set being designed and constructed to operate as one unit.

C. The star point of the generator shall be brought out and properly connected to earth.

D. The generators shall include radio and TV suppressers to BS 800.

E. The generator shall be capable of supporting 300% rated current for ten seconds for selective tripping of down line protection devices when a short circuit occurs.

2.10 VOLTAGE AND FREQUENCY REGULATION:

A. The automatic voltage regulator shall be solid state type capable of regulating the terminal voltage within ± 0.5% from no load to full load at any power factor between 0.8 lagging and1.0, cold or hot and throughout the governor range speed and shall maintain its setting for long periods without adjustment.

B. Frequency Regulation - isochronous under varying load (0 - 100%).

C. Random frequency variation shall not exceed ± 0.25% of its mean value for constant load from no load to full load.

D. It shall have response time of sufficient speed so that the alternator is ready to accept the load in the shortest time possible. Voltage adjust rheostat shall be provided for adjusting the alternator voltage within ± 5%.

2.11 INTERLOCKS AND SAFETY AUTOMATIC SHUT OFF DEVICES

Automatic safety devices shall be fitted to stop the engine in the following cases:

1. Water temperature exceeds a preset safe working limit.
2. Lubricating oil pressure is lower than a preset safe working pressure.
3. Over crank.
4. Over speed.
5. Shortage of fuel.

2.12 CONTROL PANEL FOR GENERATOR

A. The control panel shall include:

1. Voltmeter (0-500V) with selector switch.
2. Ammeters of suitable scale, 3 Nos.
3. Frequency meter.
4. Duty selector switch OFF/TEST/MANUAL/AUTO key operated.
5. Solid state voltage and frequency sensing relays.
6. Starting, cycling and shut down relays and timers.
7. Current transformer for measuring and protection devices.
8. Watt meter for unbalanced phases.
9. Power factor meter.

10. Generator running hour meter.
11. Voltage trimmer.
12. Visual and audible alarms for engine starting, engine running, overspeed, high water temperature, low oil pressure, failure to start, engine stalling or shut down, low fuel level in tanks, and alternator overload.
13. Relays for remote operation and alarm signaling as required by BAS.
14. Indicator lamps for supply available, battery charger and cooling water heater.
15. Switch for cooling water heater.
16. Manual start, stop, emergency OFF and lamp test push buttons.
17. Manual and automatic service selector switch.
18. Control switch for alternator circuit breaker, ON AND OFF.
19. All other accessories, fuses, terminal boards, small wiring, etc.

2.13 CONTROL PANEL FOR GENERATOR

A. The control panel shall include:
   1. Voltmeter (0-500V) with selector switch.

2.14 GUARANTEE OF CONTROL SYSTEMS OPERATION

A. All components of control panel for the D/G set, relays controls of all systems mentioned in this specifications shall be installed in an ambient temperature of 32° C, high relative humidity that prevail in the country

B. The Contractor shall enclose with his offer a written assurance from the manufacturer for the guarantee that all components of the control system (relays, diodes, pre-integrated circuits, semi-conductors, etc., shall withstand, operate continuously and effectively without trouble sin this high temperature and climatic conditions.

C. This assurance shall be submitted along with the offer without which offers may not be considered for adjudication of the tender.

2.15 SYNCHRONIZING AND PARALLELING SWITCH GEAR PANEL

A. The paralleling switch gear shall be of metal enclosed cubicle, free standing, made of sheet steel plates, rust proofed and stove enamelled, dust and vermin protected and shall contain but not be limited to all the devices specified herein and as required to perform the described functions. The paralleling switch gear shall consist of one paralleling switchboard for each generating set (500 KVA) plus one totalizing switchboard for the complete emergency system.

B. The paralleling switchboard shall be rated to operate at 240/415 Volts, three-phase, four wire. The bus-bar rating shall be as indicated on the Drawings.

C. Each paralleling switchboard shall contain the following controls and meters:

1. Two Paralleling Lights connected across two phases to assure proper phase rotation and proper phase synchronizing for manual and/or automatic paralleling.
2. Frequency Meter 45-55 hertz, 250 degree scale.
3. AC Voltmeter, 250 degree scale.
4. AC, 3-phase Wattmeter, 250 degree scale.
5. AC Ammeter, 250 degree scale.
6. Running Time Meter.
7. Voltmeter Phase Selector Switch.
8. Ammeter Phase Selector Switch.
9. Paralleling Light Switch (on-off).
10. Reset Switch to reset controls after load shed or engine malfunction.
11. Speed Control Switch.
12. Active Load Balancer.
13. Load Monitor with the necessary switch points.
14. Indicating Lights for:
    a. Load Shed - Red.
    b. Overcurrent Lockout - Red (sounds alarm).
    c. Reverse Power - Red (sounds alarm).
    d. Fail to Synchronize - Red.
    e. Manual Mode - Red.
    f. Automatic Mode - Red.
    g. Breaker Open - Green.
    h. Breaker Charged - Amber.
    i. Breaker Closed - Red.
15. Engine-Generator Status Indicators with Audible Alarm
    a. Generating - Green (no audible alarm).
    b. Overcrank - Red.
    c. Low Oil Pressure - Red.
    d. High Engine Temperature - Red.
    e. Low Engine Temperature - Red.
    f. Overspeed - Red.
    g. Low Fuel - Red.
    h. Low Battery Voltage - Red.
    i. High Battery Voltage - Red.
16. Controls Mounted Behind Locking Door:
    a. Auto-Off-Manual Selector Switch.
    b. Manual Operator Switch for Circuit Breaker.
    c. Frequency Adjust Potentiometer.
    d. Voltage Adjust Potentiometer.
    e. Cross-Current Compensation Switch (on-off).

D. Each paralleling switchboard shall contain the following components:
1. Contact Making Device to close on failure of engine generator, to be used for load shedding by tripping selected circuit breakers in the load circuits. Contacts to remain closed until manually reset by operating reset switch.
2. Electronic governor control panel and load sharing module.

3. Reverse Power Relay to sense a condition of reverse power flow through the generator breaker and open the breaker when the reverse power exceeds a preset level for a given time period.
4. Synchronizer to electronically adjust the engine governor to match the frequency and phase angle of the bus. Synchronizer shall maintain engine at same frequency as bus and within 10 degrees of bus for 0.5 seconds before closing breaker.
5. First Start Sensor to connect the first set to reach approximately 90% of rated frequency and voltage to the emergency bus. The first start sensors for each set shall be solid state and be sequentially enabled to prevent out-of-phase paralleling if two sets reach operating conditions simultaneously.
6. Generator main circuit breakers shall be of 4 pole air circuit breakers with over current, short circuit and earth fault protection as specified.

E. The totalizing switchboard shall be rated to operate at 240/415 Volts, three-phase, four-wire. The bus bar rating of the switchboard shall be as indicated on the Drawings. Three generators each with a capacity of 500KVA must be connected to this panel.

F. The totalizing switchboard shall contain the following controls and meters:
   1. AC Voltmeter to monitor bus voltage, 250 degree scale.
   2. AC, 3-phase Wattmeter to monitor bus power, 250 degree scale.
   3. AC Ammeter to monitor bus current, 250 degree scale.
   4. Voltmeter Phase Selector Switch.
   5. Ammeter Phase Selector Switch.
   6. Test Without Load - Normal - Test With Load Switch mounted behind locking door.

G. The totalizing switchboard shall contain the following components:
   1. Load Priority Control: The load priority control shall be micro processor based load management module and selector with programmable set points for switching ON and OFF different priority loads. It shall accomplish this function by delaying the operation of selected transfer switches. The priority control shall determine when to allow the operation of transfer switches by continuously monitoring the number of sets connected to the emergency bus.
   2. Synchronizing bracket for manual synchronization.
   3. Exerciser Clock to automatically start the engine generator sets for weekly trial start without load transfer and allow them to run for a preset time period such as 30 minutes.
   4. Contact Making Device to close at an adjustable power level. Contacts remain closed until load decreases to adjustable reset point.

H. The totalizing switchboard shall contain a continuation of the horizontal bus from the paralleling switchboards. This bus shall be terminated with cable lugs compatible with copper conductors and of sufficient capacity for the load currents involved and shall contain all load feeder ACBs and MCCBs

with rating and arrangement as shown on the Drawings and with a mimic diagram indicating the position of ACBs and MCCBs. For specification of ACBs and MCCBs refer to relevant sections of this Specification. ACBs and MCCBs shall be suitable for load management function for remote ON/OFF function as required for load shedding operation.

I. System Operation and Performance

1. The normal mode of system operation shall provide for unattended automatic paralleling of all generating sets, transfer of load and load control for the entire emergency power system. Emergency power shall be supplied to the system emergency loads within 10 seconds after interruption of the normal service. Upon receiving a signal from any of the ATS indicating a failure of normal power from a set of transformers, the system control unit will signal all engine generators to start. Generator circuit breakers are open at this time and the emergency bus is dead. The first generating set to reach approximately 90% of rated frequency and voltage signals its first start sensor. This first start sensor then inhibits the operation of all other first start sensors and initiates a closing signal to circuit breaker, connecting this generating set to the emergency bus. The priority control then initiates operation of the designated first priority transfer switch(es), applying load up to the total Kw rating of the first generating set. During this time, the other sets reach rated frequency and voltage and come under control of their synchronizers. The synchronizers adjust the generating sets to match the frequency and phase of the bus and then close the generator circuit breaker when synchronization has been achieved, connecting the oncoming generating sets(s) to the bus and activating its real and reactive load sharing circuitry (cross-current compensation control). As each additional set is connected to the bus, the priority control initiates operation of additional designated transfer switches in established sequence, connecting additional load to the bus until all sets are paralleled and all loads have been transferred and connected to the emergency generator system.

2. If one generating set fails to start after cranking for the suitable cranking period, it shall be locked off the bus and the over crank light on its paralleling switchboard shall light and the alarm sound. The priority control prevents the designated least critical transfer switch (es) from operating. The generating set may receive troubleshooting after placing its engine control function switch in the “off” position. When the generating set is operational, it may again be placed into automatic operation by returning its function switch to the “remote” position.
3. If a generating set stalls and shuts down during normal operation, its respective switchboard circuit breaker shall open, removing it from the bus. The appropriate failure light operates and the alarm sounds. The load shedding contacts in the paralleling control close, tripping a breaker in the load circuits, reducing system load to the rating of the remaining available generating capacity. After the generating set is

made operable, it can be automatically reconnected to the bus by resetting the load shed switch and engine control switch. Loads will be dumped and reinstated in accordance with their assigned priority level.

4. After normal power has been restored to all transfer switches and after the time delay on retransfer has expired, the transfer switches shall return to normal power. After the time delay on stop has expired, the generator circuit breakers shall open simultaneously and all controls automatically return to a reset condition in preparation for the next operation. The sets shall then shut down simultaneously.

J. Manual Operation:

1. The emergency power system shall have the capability of being manually operated. Each generator set may be individually started by engine control switches located on the respective engine control units. Once started and stable, the generator may be manually connected to the emergency bus through individual generator circuit breakers. After the emergency bus is energized by the first generator, each remaining generator shall be connected to the bus by utilizing permissive paralleling circuitry.
2. Each generator control unit shall be equipped with a synchronizing switch, generator breaker control switch, engine speed adjusting potentiometer and a generator voltage adjust rheostat, and facilitate manual paralleling.
3. The master control unit shall include an integral synchronizing swing parallel equipped with bus and oncoming generator instrumentation, along with synchrono scope to enable manual paralleling.

K. Provide provision for digital output signals.

Part 3 - EXECUTION

3.01 INSTALLATION

A. The Engine Generator sets, fuel oil tanks, piping and automatic transfer switches exhaust blast valves, shock isolators, etc. shall be supplied and installed as indicated on the drawings, and strictly in accordance with the manufacturer's printed instructions and recommendations.

3.02 FIELD QUALITY CONTROL

A. The completed installation shall be tested for compliance with the Specification following completion of all Site work. Testing shall be conducted by a representative of the manufacturer and in the presence of the Engineer. The Engineer shall be notified in advance. Certified copies of test procedures and results shall be forwarded to the Engineer.

B. Simulated Power Failure Test: Engine-generators shall be made ready for automatic operation and started by means of the test transfer switch on the automatic transfer switches. Units shall run for the duration of all time delays and then automatically shut down.

C. Load Test: Engine-generators shall be operated at approximately the following loads, in the order shown and without interruption. (Loads calculated with consideration for site conditions such as elevation, temperature, etc.)
   1. Four hour operation at half rated load.
   2. One hour operation at three quarters of rated load.
   3. Full load test and run for one hour at 110% load giving the temperature of the engine jacket water. The contractor shall provide "load banks" with loads over and above available building load sat the time of testing generator up to 110% of its rated KVA/KW output. Records shall be maintained throughout this period on water temperature, oil pressure, ambient air temperature, barometric pressure, voltage, current, frequency, kilowatts and power factor and submitted to the Engineer.

D. The tests and checks shall include, but not be limited to the following:
   1. Checking that the base and set are level in all directions, checking alignment of engine and generator and vibration isolator's location and proper installation.
   2. Checking levels of water and sump oil and the operation of cooling water heater.
   3. Checking of battery electrolyte level and specific gravity.
   4. Checking of valve clearances, fuel pump setting, governor setting, pipe line connections, and exhaust piping and flexible connections.
   5. Checking of fuel pipe lines, fuel pumps, tank level gauges and level control switches operation.
   6. Checking of all connections on alternator control panel's boards.
   7. Checking of signaling and control circuits for correct operation.
   8. Checking of insulation resistance of stator, rotor and exciter windings of the generator.

9. Checking proper operation of instruments and gauges, speed, voltage and frequency.
10. Checking of proper operation of engine safety devices.
11. Checking of effectiveness of radio suppression.
12. Verifying proper starting of motors supplied from the generator.
13. Checking the shock isolators and blast valve installation.

E. System Responsibility: The generating sets and automatic transfer switches shall be matched and interconnected according to manufacturer's recommendations, to prevent the emergency generating system from stalling or faltering due to momentary or temporary overloads beyond system rating, from distribution faults, motor starting loads or momentary loss of power from one or more prime movers.

F. The generating sets and automatic transfer switches shall be supplied, tested and serviced by the same company. The manufacturer shall have parts and service available through a local distributor.

G. Diesel shall be filled with full capacity in the daily tanks initially once by the Contractor after approval of the installation by the local petroleum company without any extra cost to the Employer.

H. Shock isolation is to protect the equipment not designed for severe shock and they must be mounted on special shock isolators that prevent the propagation of these loads effects.

SECTION 265100
LIGHTING

SECTION 265100
LIGHTING

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, Procurement, installation, testing and commissioning of the lighting systems all as required and/or in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   1. Indoor Lighting
   2. Outdoor Landscaping and Floor Lighting
   3. Emergency Lighting

1.02 SYSTEM DESCRIPTION

A. Lighting fittings complete with controls, control gear, supports and accessories inclusive of all lamps of the type and wattage specified.

1.03 SUBMITTALS

A. Shop Drawings: Submit to the Engineer, in accordance with the requirements of the Contract Documents for lighting fittings. Include manufacturer's literature, dimensions, data, photometric curves, and operation and maintenance instruction manuals.

B. Shop drawings for light fittings shall include recommended installation method for each type and on field mounting arrangements either as a typical or as location based for each type.

C. Shop drawings for wall switches, push button stations, photo-cells shall include manufacturer's literature, ratings, data and dimensions.

D. Shop drawings for timers, contactors shall include manufacturer's literature, ratings, data, dimensions and schematic diagrams.

E. The position of all external lighting units shown on the drawing are to be taken as approximate only and the exact location of lighting units will be indicated and marked at site for approval by the Engineer.

F. Submit fitting samples for all types and models prior to fitting shipment. Samples of catalog items and customized fittings shall be complete, including mounting details.

G. Visual Mock-ups: Following approval of samples construct visual mock-ups as follows:
   1. Provide as required, located on the job site where directed, assembled to simulate final conditions, sample light fittings, suspended ceiling, supports and other fittings and features.
   2. Adjust or modify visual mock-ups to the satisfaction of the Engineer. All permanent work shall comply in all respects with the finally approved mock-ups which themselves may be used in the permanent work.

H. All external light fixtures shall be certified by VDE/ASTA. VDE/ASTA certificate shall be submitted for the specified IP Protection Class by the manufacturer.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: All equipment and accessories shall be supplied and installed to comply with the relevant IEC Standards or demonstrated equal approved Standards.

1.	IEC-62717	Luminaires, performance requirements
2.	IEC 60598-1	Mechanical & electrical construction for LED luminaires
3.	IEC- 61140	Electrical protection classes.

1.05 WARRANTY, RESPONSIBILITIES, MAINTENANCE AND ACCEPTANCE

A. Refer to Annex A, showing schedule of equipment warranties, maintenance obligations and financial security

Part 2 - PRODUCTS

2.01 MANUFACTURERS

Refer to lighting fixtures schedule.

1. 3 F Filippi
2. Disano
3. Cooper
4. Ecolink
5. Jiso
6. C Luce
7. Or approved equal

2.02 MATERIALS

1. Lamps and Luminaires
   A. General
      1. Lamps shall be supplied and installed in all lighting fixtures listed in the Schedule of Lighting Fixtures on the Drawings.
      2. Lamps used for temporary lighting services shall not be used in the final lamping of fixture units.
      3. Lamps shall be of wattage and type as shown in the Schedule of Lighting Fixtures.
      4. Lamps for permanent installation shall not be placed in the fixtures, until so directed by the Engineer, and this shall be accomplished directly before the site areas are ready for occupancy by the Employer.

   B. LED
      1. LED luminaires shall provide a continuous and controllable light source. Lamp output and dimensions shall be in accordance with contract drawings and specifications. LED luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED luminaires to operate in ambient temperature of 0°C to +65°C. Luminaires to have minimum life of 30,000 hours.
      2. All LEDs used in the LED luminaires will be of high brightness and proven quality. All LEDs shall be driven digitally with pulse width modulation control to prolong life and maintain consistency of lumen output.
      3. All connections to luminaires will be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

4. Fuse Protections: All power supply outputs will be either fuse protected or PTC-protected. All luminaires will have built-in fuse protection. All power supplies will provide for knockouts for conduit connections or clamp-style connection for the low voltage wiring.

C. General

All lighting fixtures will be provided with LED lighting types ,locations and quantities will follow the new standards and architectural plan .

Illumination levels (lux) shall generally be in accordance to CIBSE Lux level criteria for each space type and/or specific function. These lighting levels shall be considered average maintained target values measured at the work surface.
Generally, LED light fittings shall be employed recessed or surface mounted for the project.

Movement sensors shall be used in, hallways, corridors and stairs.

Luminaires will be the standard products of reputable manufacturers and will be the best of their respective kind. The protection class of all luminaires will be specified in accordance with the nature of the area where they will be installed.

Luminaires in parking and humid areas will be used with IP65.

The lux level must be as the following:

1.	Control room	400 lux
2.	Electrical rooms	250 – 300 lux
3.	Transformer and Generator rooms	300 lux
4.	Mechanical rooms	250 – 300 lux

The degree of protection must be as the following:

1.	Control room	IP-21
2.	Electrical rooms	IP-43
3.	Mechanical rooms	IP-54
4.	External light	IP-65

D. Lighting Fittings

1. All fittings and associated equipment shall be of the proven best quality and current models, for which replacement parts and lamps are and will be available for the normal expected useful life of the fittings and associated equipment.

2. All fittings installed shall be compatible with the appropriate ceiling system. The fixing methods of mounting shall conform to the following:
   - Each surface mounted fitting shall be mounted at two points on each side.

3. All fittings shall be installed true and level and shall be free of light leaks, warps, dents and all other irregularities.
4. Lamp wattages and sizes shall be as described on the fitting types.
5. All internal wiring of lighting fittings shall be carried out with silicon rubber or heat resistant insulated tinned copper conductor of adequate size and shall be clipped neatly in position.
6. Each fitting shall be provided with an earth terminal.
7. Exposed parts of fittings and associated equipment shall be finished as specified or as directed by the Engineer.

2.03 CONTROL GEAR

A. Control gear shall be suitable for the operation of all types of lamps and for 220 Volts, single phase, 50 HZ supply and ambient temperature of up to 45 degree and consist of the following unless otherwise mentioned:
   1. High frequency electronic control gear with integrated inrush current limiter, harmonic suppresser, flicker free warm start, suitable for high switching frequency.
   2. Shall be suitable for project climatic conditions.

B. Overall power factor of discharge LED lamps shall not be less than 0.9.

2.04 BATTERY BACK-UP LUMINAIRES

A. Luminaires with battery back-up emergency of exit lights are shown in the drawings.

B. Battery shall be suitable for 3 hours operation in case of normal power failure. Built-in charger shall be provided with the unit.

C. Separate charger power supply shall be taken from the LP for charging the batteries and shall be incorporated in the shop drawing by the Contractor.

2.05 LUMINAIRE DATA SHEETS

The luminaire data sheets appended to this section define the quality and design/performance of all luminaires which shall be supplied and installed, with locations and quantities as indicated on the Drawings.

Part 3 - EXECUTION

3.01 LIGHTING FITTINGS

A. The Contractor shall furnish and install all inserts, anchors, studs and hangers for the support of lighting fittings and associated equipment and make all necessary adjustments required to obtain a true and level installation.

B. Plaster rings shall be securely fastened to the ceiling support channels, such that the bottom of the plaster ring is flush with the finished ceiling (unless specifically directed otherwise on accepted shop drawings), and such that there will be no forces on the actual plaster during relamping. The plaster or other finish shall be screened flush with the bottom of the plaster ring. All plaster shall be cleaned from inside the plaster ring, to allow proper seating of the fitting.

C. Pendant fittings shall hang plumb with approved stem hangers.

D. All the external lighting installation works shall be in accordance with best modern practice and in compliance with this Specification.

E. Current, voltage and insulation resistance readings for each circuit shall be taken and tabulated by the Contractor. Any indication of ground fault which are a result of work performed by the Contractor shall be thoroughly investigated and remedied before final acceptance of the installation.

F. All the external lighting installations and details shall, in general, comply with the Standard Specifications for external lighting as applicable.

3.02 SCHEDULE OF LIGHT FIXTURES (refer Annexure for Fixture Schedule)

Supply and install, connect, test and commission the light fittings as per the fixture schedule. Detailed specification of the light fittings with respect to material, finish, quality standard, IP protection etc. are be provided with catalogue number mentioned for each type. Verify voltages to all fittings with the Engineers. Submit samples of each type of fitting including specified fittings for final approval.

Division 28 - Electronic Safety and Security

SECTION 283133
FIRE ALARM SYSTEM

SECTION 283133
FIRE ALARM SYSTEM

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Design, engineering, procurement, installation, testing and commissioning of a complete fire alarm and detection systems as shown on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
   1. Main Fire Alarm Panel
   2. Automatic and Manual Detectors.
   3. Alarm Horns and Flashers
   4. I/O Unit
   5. Power Supply

1.02 REFERENCES

A. Lebanon Civil Defense
   1. Relevant publications

Lebanon

B. National Fire Protection Association (NFPA)
   1. Relevant Publications

1.03 SUBMITTALS

A. Product Data: Submit to the Engineer for information only in accordance with requirements of the Contract Documents copies of Manufacturer's data on Fire Alarm and detection systems including but not limited to diagrams and instructions for installation, operation and maintenance, and also include standard or typical riser and wiring diagrams.

B. Shop Drawings: Submit to the Engineer in accordance with the requirements of the Contract Documents for the Fire Alarm Systems. Include details showing equipment/device locations and connecting wiring of entire fire alarm and detection systems. Include wiring diagrams and riser diagrams.

C. Sample: Submit to the Engineer in accordance with the requirements of the contract documents, samples of fire alarm system including accessories for approval.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Fire Alarm Contractor shall be of the reputable name of MEP Sub-Contractors.

1.05 SYSTEM DESCRIPTION

A. Fully automatic fire detection and alarm system as described in detail in this section and as shown on the drawing shall be provided. The offered system should be able to monitor, control and graphics for all points and functions and shall connected to the existing main FACP related to the whole building.

Part 2 - PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm Equipment:
   1. Simplex - USA
   2. Edwards - USA
   3. Gent - UK
   4. Siemens – Germany
   5. Honey Well – (USA OR Europe)
   6. Approved equal.

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

2.02 MATERIALS

A. General
   1. Provide a complete high quality intelligent, analogue, addressable central fire alarm and detection system which shall be composed of fully electronic-operated hardware of the latest technology in the field to achieve maximum facilities in identifying the source of fire outbreak in its very early stages and minimum alarm annunciation of false fire phenomena.
   2. The capacity of the system shall be sufficient to perform all functions specified in the Contract Documents plus 20% spare capacity.

B. Furnish and install all required wiring, controllers, control elements, installation, sensors.
C. Furnish and install separate fire alarm, visual and audible, panels for firefighting system as specified hereafter including all required wiring, interface units, master elements, etc. This panel to be software interfaced with the main fire alarm panel to monitor all signals from main fire alarm panel. Refer to fire fighting specification and coordinate with fire fighting contractor. The panel shall be approved by the Civil Defense.
D. The product shall be compatible for operating with BMS and coordinate with BMS equipment manufacturer and BMS Contractor.

2.03 SYSTEM HARDWARE CONSTRUCTION

A. Automatic Fire Detectors:

1. Includes photoelectric smoke detector, temperature rate-of-rise with maximum limit heat detectors and linear smoke beam detector and multi-sensor type smoke detectors. Any of the detectors shall fit in the same detector base so that only the detector head could be changed at any time without changing the base or disconnecting any wiring.
2. The base or the detector head shall be equipped with integrated hermetically sealed module for individual addressing and more intelligent signal processing with built-in alarm indicator. The base shall be supplied with a removable dust cover to protect the contact area during installation and construction phase of the building.
3. The detectors provided shall be characterized by the following features as a minimum:
    a. The detector shall be of plug-in design for installation in pre-wired bases, with a built-in mechanism which allows mechanical locking of an installed detector head.
    b. The detectors shall be of impact proof material and vibration proof when fitted to the bases, with corrosion proof contacts.
    c. The detectors shall be protected against transient interference and its response behaviors must not be affected by the changes in operating voltage.
    d. Reversed polarity or faulty zone wiring shall not damage the detector.
    e. The response sensitivity of each detector shall be field-adjustable to one of at least three predetermined (factory calibrated) levels. It shall be possible to test the sensitivity of a detector in the field. Sensitivity of a detector can be tested and adjusted through the software of the system.
    f. The response (activation) of a detector shall be clearly visible from outside by a flashing light of sufficient brightness.
    g. A built-in integration circuit shall allow the suppression of brief deceptive phenomena.
    h. The detector shall be designed for fast and simple cleaning and with a built-in barrier to prevent entry of insects into the sensors.
    i. The detector shall be inserted into or removed from the base by a simple push twist mechanism to facilitate exchange for cleaning and maintenance.
    j. The detector shall connect to the local control unit via a fully supervised two wire feedback loop circuit (class A wiring).
4. In addition to the previous features the different types of detectors shall be specifically specified according to the following:
    a. Multi-sensor Smoke Detectors:
        i) The multi-sensor analog detector shall use a light scattering type photoelectric smoke sensor and a fixed temperature type heat sensor to sense changes in air samples from its surroundings. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. Separately mounted photoelectric detectors and heat detectors in the

same location are not acceptable alternatives. Detector sensitivity shall be adjustable and shall be unaffected by changes in temperature, humidity and barometric pressure.

ii) The smoke entry windows of the detector shall be suitable for local air current patterns, and shall be installed within safe location as recommended by the manufacturer.

iii) Detector operation shall incorporate a time delay, response integration circuit to minimize false alarms of smoking with built-in facility to isolate or connect this circuit according to the need of the protected room.

iv) Detectors shall be of plug-in design for installation on pre-wired bases.

v) A built-in indicator in the detector base shall indicate detector operation in alarm conditions.

vi) The detectors shall be designed to provide satisfactory service without any harmful effects for prolonged and continuous periods with the following conditions:

vii) Ambient temperature : 0°C to 45°C

viii) Relative humidity : 5% RH Continuous without condensation.

ix) Smoke detectors and accessories in the explosion-proof areas shall be intrinsically safe type.

b. Heat Detectors: Heat detectors shall be semi recessed or surface mounted, solid state with combination fixed temperature and rate of rise detection operating in temperatures above 58° C or rate of rise of 10° C/minute. They shall have removable protective cover to enable thorough cleaning and have the sensors protected against mechanical damage. A built-in indicator in the detector base shall indicate detector operation in alarm conditions.

c. Photoelectric Smoke Detectors: Provide intelligent photoelectric smoke detectors. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity.

d. Optical Smoke Detectors: Comply with UL 268, “Smoke Detectors for Fire Protective Signaling Systems.” Include the following features:

i) Factory Nameplate: Serial number and type identification.

ii) Operating Voltage: 24 VDC, nominal.

iii) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.

iv) Plug-In Arrangement: Detector and associated electronic components are mounted in a module that connects to a fixed base with a twist locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be

required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the at the control unit.

v) Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (one every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
vi) Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
vii) Each detector shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a “wrong device”, the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5%obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a “Wrong Device” trouble condition.
viii) The detector’s electronics shall be immune from false alarms caused by EMI and RFI.
ix) Addressability: Detector includes a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
x) Removal of the detector head for cleaning shall not require the setting of addresses.
xi) Type: Optical smoke detectors shall be of the photoelectric type.

B. Addressable Manual Alarm Call Points:

1. The manual call point shall be electrically compatible with the standard range of automatic detectors so that it can be connected directly into a supervised two-wire zone of the control units for feedback loop circuit (class A wiring).
2. The manual call point shall be of streamlined and flat appearance permitting its use as flush mounted unit as approved by the Engineer.
3. The unit cover must be secured against unauthorized removal. Every removal of the cover must release an alarm.
4. All inscriptions, texts and marks must be on the manual call point front plate, not on the glass, so that the glass can easily be replaced anywhere. The glass must be secured in the cover against falling out.
5. The manual call point shall be designed for fail-safe operation. The alarm contacts shall be of self-cleaning design to prevent failure after a prolonged period of inactivity.
6. The call point shall have a built-in lamp, automatically confirming its actuation, and it shall be possible to test the call point without destroying the seal or removing the cover.

7. The call point alarm actuating mechanism shall be equipped with strain limits, preventing permanent deformation of P.C.B. and contacts.
8. The manual call point shall be equipped with a self-holding device to maintain the alarm condition until reset by an authorized person.
9. The manual call point housing shall accommodate the sealed electronic circuit for an individual address system.
10. The manual call point must be designed to permanently withstand corrosion, as defined by international standards.

C. Addressable Control Module (Control Element):

1. The addressable control module shall be designed to convert specific signals on an addressable detection line from the control unit into control functions to actuate other modes as specified elsewhere.
2. The output contact of the addressable control module shall be rated for 0.5A and 220 VAC.
3. The addressable control module shall have an input for a connection of an external contact to provide a confirmation signal to be sent back to the control unit via the detection line after the control function has been carried out.
4. The addressable control element shall be connected to the control unit via a fully supervised two-wire circuit.
5. The control function to be assigned to the addressable control element shall be programmable at the control unit.
6. The addressable control module shall have a built-in response indicator lamp to flash during activation.
7. The addressable control module shall have screw less terminals with built-in strain limits to prevent permanent deformation of the terminal and weakening of contact pressure.

D. Alarm Devices:

1. Local alarm horns shall be flush, suitable for wall or ceiling, mountings, of suitable construction to match the interior design and as approved by the Engineer. Fully electronic, low voltage, low power consumption, matching the system and of rated sound level within 85 db at 1 meter and 800 Hz continuous tone.
2. General alarm horns shall be fully electronic of combined visual/audible alarm horn and alarm flash light in a weather proof protective housing for out-door areas. The horn shall be of multi-tone switchable facility where different tones could be selected within the device provide continuous, intermittent or siren tones at a rated sound level within 105/115 db at 1 meter and 1000 Hz.

E. Central Facp

1. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete

control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.

a. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 25 mm high. Identify individual components and modules within cabinets with permanent labels.
b. Mounting: Surface.

2. Alarm and Supervisory Systems: Separate and independent in the FACP. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.

3. Control Modules: Include types and capacities required to perform all functions of fire alarm systems.

4. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.

5. Indicating Lights and System Controls: Individual LED devices identify zones transmitting signals. Zone lights distinguish between alarm and trouble signals, and indicate the type of device originating the signal. Manual switches and push-to-test buttons do not require a key to operate. Controls include the following:
   a. Alarm acknowledge switch.
   b. Alarm silence switch.
   c. System reset switch.
   d. LED test switch.

6. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.

7. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation, supervision, and control.
   a. Visual display unit capable of displaying 16 lines 40 characters backlit display (white on blue).
   b. Built-in 40 character thermal printer operating when the access door is open There shall also be an option to enable the printer when the door is closed.
   c. Built-in full qwerty keyboard. Labeling of devices shall be done from this keyboard. Also, any correction in label if required, shall be done by this keyboard only.

8. Simple menu driven function keys with password protection shall allow users to an extensive range of software based features such as:
   - Last 100 fire events
   - Last 255 system events
   - Current fault and warning logs.
   - Analysis of analogue sensor information
   - Interrogation of sensor cleanliness
   - Loop map connections
   - Enable/ disable sensors, zones, sounders, interface unit channels.
   - Fire plan configuration menus
   - Outstation label changes
   - Address allocation
   - Status of outstation
   - Status of all cards
   - Printer on, off, line feed and test facilities.
   - Address allocation including soft addressing.

9. Instructions: Printed or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

10. VOLTAGE AND POWER SUPPLY: Main FACP is to provide 24 V d.c. to all zone alarm initiating and alarm signaling devices and is to be designed to operate from 220 V a.c., 50 Hz 2-wire, earthed power supply. Power supply is to be an integral part of the main fire alarm panel, switch mode solid state design, with built in transient protection (up to 6 kV), including UL recognized EMI filter, spark gaps and varistors. Additional power supply units are to be provided for the amplifiers. The power supply is to provide diagnostic LEDs to notify operator upon AC power and/or the control unit CPU failure.

11. Monitored output relays for MDB, general services, lift, fire fighting panel, fire doors, motorized dampers …etc as required by the standard (B5 5839) and to the satisfaction of the engineer. Outputs shall allow for segregated selective control per floor and/or area application.

12. Monitored input relays from fire pump, fire fighting panel, MDB, generators panel , motorized fuel valves, fuel pumps & fire dampers.

13. Inputs to fire alarm panel shall include but not limited to:

a) Failure or disconnection of power supply.
b) Failure of protective device.
c) Valve tamper at fire pumps.
d) Flow switches at fire pumps.
e) Fire pumps power loss.
f) Fire pumps phase reversal.
g) Generators start failure.
h) Generators low fuel.
i) Generators low oil pressure.
j) Each fire damper status.
k) Extinguishing panels' status (trouble, pre-alarm, countdown & release.
l) Solenoid fuel valves status.
m) Fuel pumps status.

14. In addition to the above, all other necessary controls, elements and accessories shall be included to provide a complete and efficient panel conforming to the requirements of BS 5839: part 4: 1988.

Part 3 - EMERGENCY POWER SUPPLY

A. General: Components include nickel-cadmium battery, charger, and an automatic transfer switch.
1. Battery Nominal Life Expectancy: 20 years, minimum.

B. Battery Capacity: 72 hours: including supply of sounders, electronic bells, warning signs, strobe lights, control signals, full alarm load for 30 minutes.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

Part 4 - ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall or to a circuit-breaker shunt trip for power shutdown.

Part 5 - WIRES AND CABLES FOR SOUNDERS, BELLS, CONTROL SIGNALS & LOOPS INCLUDING ADDRESSABLE SOUNDERS

A. Certified to have passed IEC 331 and 332 flame resistance and fire retardant tests or BS 7629: 1993 and BS 6387. Working voltage is to be maintained in a flame of 1000 deg. C for at least 20 minutes or 750 deg. C for three hours. Cables are to be silicone rubber insulated, with overall PVC sheath bonding to coated aluminum foil (Pirelli FP 200 GOLD by Pirelli Cables) or MICC cables or other equal and approved. Fire rated insulated conductors similar to Pirelli FP100 in surface mounted rigid steel conduits or concrete embedded heavy gauge rigid PVC conduits are accepted. Conductors are to be copper of minimum size 1.5 mm^2 and/or larger such that voltage drops at full load is below 5%. The wiring is to be true class “A”.

Part 6 - CONDUITS AND RACEWAYS

A. Flame retardant rigid PVC heavy gauge concrete embedded or steel conduits for surface mounted for Pirelli FP100 (locally manufactured conduits and boxes shall not be accepted). MICC or FP200 GOLD cables do not need PVC conduits. All connection blocks shall be fire resistant similar to “WAGO” installed in metallic red painted boxes.

Part 7 - EXECUTION

7-1 EQUIPMENT INSTALLATION

A. Connect the FACP with a disconnect switch with lockable handle or cover.

B. Manual Pull Stations: Mount semi flush in recessed back boxes.

C. Ceiling-Mounted Smoke Detectors: Not less than 10 cm and not more than 5 meters from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 10 meters apart in any direction.

D. Wall-Mounted Smoke Detectors: At least 10 cm, but not more

than 30 cm, below the ceiling.

E. Smoke Detectors near Air Registers: Install no closer than 150 cm.

F. Audible Alarm-Indicating Devices: Install not less than 25 cm below the ceiling (or false ceiling). Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.

G. Visible Warning signs: Install above exit doors at least 15 cm above top of door frame.

H. FACP: Surface mount with tops of cabinets not more than 1830 mm (72 inches) above the finished floor.

7-2 WIRING INSTALLATION

A. Wiring Method: Install wiring in rigid PVC heavy gauge conduits except for fire resistant cables when unconcealed. Conceal raceway except in unfinished spaces and as indicated.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

E. Risers: Install vertical cable risers to serve the fire alarm system (sounders bells and control devices) as indicated on riser diagram.

7-3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Basic Electrical Materials and Methods."

B. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification."

C. Install instructions frame in a location visible from the FACP.

D. Paint power-supply disconnect switch red and label "FIRE ALARM."

7-4 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

7-5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pre-testing, testing, and adjustment of the system. Report results in writing.

B. Pre-testing: After installation, align, adjust, and balance the system and perform complete pre-testing. Determine, through pre-testing, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pre-testing: After pre-testing is complete, provide a letter certifying the installation is complete and fully operable,

including the names and titles of witnesses to preliminary tests.

D. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to procedures outlined in BS 5839. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Test all conductors for short circuits using an insulation-testing device.
3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.
4. Verify that the control units are in the normal condition as detailed in the manufacturer's operation and maintenance manual.
5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, graphics (on separate computer), signal tones, and annunciator indications.
8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of tests.

H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

7-6 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

7-7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
   1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours' training.
   2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
   3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

7-8 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

LEBANESE REPUBLIC
GENERAL DIRECTORATE OF THE PRESIDENCY
PRESIDENTIAL PALACE COMPOUND- BAABDA

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

TENDER DOCUMENTS

VOLUME 3

BILL OF QUANTITIES – R1

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

VOLUME 3 - BILL OF QUANTITIES

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GENERAL PREAMBLE

SPECIFICATIONS

The Works as shown on the Drawings and described in the Bill of Quantities shall be executed and completed fully in accordance with the provisions and the requirements contained in Volume 2 - Specifications.

DRAWINGS

The Drawings pertaining to the Works are identified and listed hereunder and they are to be read and construed in conjunction with Volume 1 - Conditions of Contract and General Requirements, Volume 2 - Specifications, and this Volume 3 - Bill of Quantities.

The Contractor's attention is drawn to the necessity for all dimensions and elevations shown on the Drawings to be physically checked and co-ordinated on the Site prior to the setting out of works, during the progress of works and prior to ordering, purchasing or manufacturing of installed components and equipment. The Contractor shall be deemed to have made due allowance in his Bid for identifying and resolving any such dimensional discrepancies which may arise.

The Drawings are as numbered and listed on Drawing entitled 'List of Drawings'.

BILL OF QUANTITIES

Symbols and Abbreviations

The following symbols and abbreviations, where used in this Bill of Quantities, have the following meanings:

m	=	linear metre
m2	=	square metre
m3	=	cubic metre
cm	=	centimetre
mm	=	millimetre
Nr or No	=	number
kg	=	kilogramme
T	=	tonne
"	=	inches
Item	=	lump sum amount
%	=	percentage
Qty	=	quantity
Drg or Dwg	=	Drawing

Generally

The Bill of Quantities are to be read in conjunction with Volume 1 - Conditions of Contract and General Requirements, Volume 2 – Specifications, the Drawings, and these Preambles, all of which shall be taken as being mutually explanatory to each other, and construed accordingly.

The Works have been measured in accordance with the descriptions and notes described in the Bill of Quantities, which shall apply equally to both proposed andexecuted Works.

The Contractor shall not rely upon the descriptions, the dimensions therein, nor the quantities given in the Bill of Quantities for the purpose of ordering, purchasing or manufacturing of any materials, components or equipment.

The Contractor is required to provide with his Bid, in accordance with the requirements prescribed in the Bidding Documents, a detailed analysis of all unit rates and prices inserted in the Bills of Quantities. This shall include a break down of each unit rate and price, showing the allocation of cost for labour, materials, plant, equipment and other charges. The Employer or the Engineer shall have the right, and the Contractor shall provide if so requested, a further analysis of any or all unit rates and prices, including a detailed breakdown of "other charges".

Descriptions

The descriptions of the work items as set out in the Bill of Quantities are approximations only and are not necessarily, nor are they to be taken as the precise and complete descriptions of work to be performed by the Contractor in the execution and completion of the Works, and in fulfillment of his obligations under the Contract.

Headings and sub-headings to groups of items in the Bill of Quantities are to be read as part of the descriptions of the items to which the headings and sub-headings apply.

The general and detailed requirements of the Specification are not repeated in the descriptions of the items in the Bill of Quantities, other than cross-referencing for the purposes of identification.

Where work cannot be fully ascertained or accurately described, or where the quantity of work required cannot be determined it is denoted as ‘PROVISIONAL’. Such work is to be carried out only in accordance with the instructions of the Engineer and may, if the Engineer so decides, be omitted entirely.

The term EXTRA means that work so described involves extra cost over the basic work in which it occurs. No deduction of the basic quantity is made in respect of the extra work so described.

Quantities

The quantities set out in the Bill of Quantities are estimated quantities only and they are not to be taken as the actual and correct quantities of work to be performed by the Contractor in the execution and completion of the Works, nor are they intended to limit the amount of work to be performed under the Contract.

The Contractor is deemed to have visited the site, satisfied himself with the existing conditions and to access by the cleint. The contractor is to allow in his tender for all items, materials, workmenship which in his openion make part of the work and are not mentioned in the Bill of Quantities as no extra payment will be allowed on the ground of such claim.

Upon completion, all work will be re-measured in accordance with the Contract, following the descriptions and notes contained in the Bill of Quantities and these Preambles.

Works are measured net as fixed in position except where otherwise stated in a measurement note applicable to the work. Excavation and earthwork in particular, are measured on the basis of net volumes required to accommodate only the Permanent Works as shown on Drawings, without allowance for any additional volume requirements for working space, supporting sides, battering of sides, bulking of volumes and the like, etc.

Quantities as measured are given to the nearest whole unit, except that any quantity less than one unit is given as one unit.

Pricing

The Contractor shall be deemed to have fully checked the descriptions and quantities contained in the Bill of Quantities against the Drawings and Specifications to ensure that the unit rates and prices inserted by him in his Bid, include for the full cost of executing and completing the work described, including for all ancillaries and associated works which are indicated or reasonably inferred from the Drawings and Specifications and necessarily required for the proper and timely execution and completion of the Works in accordance with the Contract.

Unit rates and prices inserted in the Bill of Quantities shall be fixed and, except as provided for in the Contract not subject to adjustment, in respect of any rise or fall in the cost to the Contractor of undertaking, executing and completing the Works.

The cost of any items of work in the Bill of Quantities, for which no unit rate or price has been inserted by the Contractor, shall be deemed to be covered by and included in the other rates and prices inserted in the Bill of Quantities.

Unless otherwise stated, all costs necessarily incurred in complying with the provisions and requirements of the Conditions of Contract and General Requirements are deemed to be included with the works, as applicable. Unit rates and prices inserted by the Contractor against the work items in the Bill of Quantities, shall be deemed to cover for all such costs; including but not necessarily limited to the following, as applicable:

- on-site and off-site supervision and management,
- site administration and security,
- insurances, bonds and guarantees,
- water for the works,
- lighting and power for the works,
- temporary roads, hardstandings, crossings and the like,
- temporary fencing, hoardings, screens, barriers, foot-ways, guardrails and the like,
- giving notices and making applications, including the payment of fees and charges in connection therewith,
- safety, health and welfare of workpeople, and of employees, users and occupants of existing buildings and facilities on the Site,
- compliance with traffic regulations,
- maintenance of public and private roads, services and adjoining property,
- control of noise and pollution, prevention of fire and compliance with all other statutory and general obligations,
- samples of materials and testing of materials, including providing equipment for testing,
- preparation and submittal of drawings, reports, records, certificates, notices, proposals, designs, details, calculations and other information and data required by the Specification,
- compliance with all other requirements, provisions, responsibilities and obligations contained in the Contract Documents.
- Temporary facilities for the Consultant / Engineer including Site offices - Furniture - Equipment.

Unless otherwise stated, all costs necessarily incurred in complying with the provisions and requirements of the Specifications and Drawings are deemed to be included with the work, as applicable. Unit rates and pricesinserted by the Contractor against the work items in the Bill of Quantities, shall be deemed to cover for all such costs; including but not necessarily limited to the following, as applicable:

- mobilisation: including bringing to and providing on Site, all Contractor's Equipment and temporary works; carrying out enabling tasks and providing all temporary services necessary to commence and undertake the Works,

- labour and all costs in connection therewith,

- materials, products, equipment, goods, supplies and consumables, and all costs in connection therewith,

- Contractor's Equipment, including but not limited to: plant, machinery, scaffolding, tools, vehicles and the like, and all costs in connection therewith,

- temporary works and all costs in connection therewith, including but not limited to: designing; preparing and submitting shop drawings; installing, maintaining, adapting, clearing away and making good as necessary,

- work at any location or depth,

- work in small or isolated quantities,

- curved, sloping, raking or battered work,

- cleaning and protection of all work,

- protection of all existing buildings and facilities, structures, utilities, site improvements, trees and vegetation, features, pavements and other facilities on and adjacent to the site, which are to remain upon completion of the work,

- all other enabling tasks, associated and subsidiary components and items of ancillary work, which are indicated or reasonably inferred from the Specifications and/or Drawings, and which are necessary to perform and complete the work described,

- demobilising the Site upon completion of the Works, including but not limited to: removing from Site all Contractor's Equipment and temporary works materials, clearing and removing from the Site all Contractor's rubbish, debris and surplus materials, and reinstating and restoring the Site to its' original condition,

- establishment costs, overhead charges, profit and risk.

- All needed works to execute the items

REHABILITATION OF MAIN ELECTRICAL ROOM / NEW GENERATORS ROOM IN RESIDENTIAL PALACE - PHASE 2

BILL OF QUANTITIES

GENERAL SUMMARY

	PRICE SUMMARY	Amount (U.S $)
Part-1	Civil, Structural and Architectural Works From Summary	0.00
Part-2	Mechanical Engineering Services From Summary	0.00
Part-3	Electrical Engineering Services From Summary	0.00
	Total:	**0.00**

- VAT (When applicable)

GRAND TOTAL PRICE CARRIED TO FORM OF BID: **0.00**

(Total Price in Words) U.S. DOLLARS:

REHABILITATION OF MAIN ELECTRICAL ROOM / NEW GENERATORS ROOM IN RESIDENTIAL PALACE - PHASE 2

PART-1
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

Item	Description	Unit	Quantity	Unit Rates US.S	Amount US.$.
	CHAPTER 1 - SITE PREPARATION AND DEMOLITION				
1.1	**SITE PREPARATION**				
	Site Clearance				
1.1.1	Clear and prepare site areas generally, as required to enable and facilitate all new construction, including removal of unwanted trees, planting, ware houses and removal of existing building which is composed of many floors and any structure. etc.	L.S.	1.00		0.00
	Site Protection				
1.1.2	Protect, safeguard and support as necessary existing buildings, structures, facilities, site areas, trees and planting, services and utilities; etc., which are to remain upon completion, from damage due to construction operations and activities	L.S.	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 2 - SELECTIVE DISMANTLING AND DEMOLITION AND REPAIRS/EXTERNAL WORKS				
2.1	**Demolition Work** Demolition of hollow concrete blocks works concrets, reinforced concrete & wall share exists including doors, frames etc…... As shown on drawings				
2.1.1	Demolition of existing walls (generator room)	m2	155.00		0.00
2.1.2	Roof (TOT) generator room	m2	125.00		0.00
2.1.3	Demolition of existing walls (electrical room)	m2	27.00		0.00
2.1.3	Demolition of existing tiles in the toilet (control room)	m2	20.00		0.00
2.1.4	All excavation works required to achieve design levels. Excavation below baseline level for foundations, footings, tie beams, retaining walls, etc… and in accordance with soil reports, specifications, drawings, and the engineer's instructions	m3	165.00		0.00
2.2	**DISMANTLING WORK** Excavate to any depth in any type of material, INCLUDING for breaking out any existing walls, paving, footings, underground walls, obstructions, utilities and the like; supporting sides of excavations; shoring, strutting, supporting and protecting existing structures adjacent; dewatering; trimming, compacting and testing; backfilling and filling to final design elevations; removal of surplus excavated material from site; and all other related ancillaries as indicated or required				
2.3	**BACKFILL** Backfill for leveling grading levels under slab on grade complete with all necessary compaction laboratory tests for base sub grade & retain sub grade of CBR is 10% or more, if CBR is less than 10%, replace a 50 cm layer with material of good soil free of deleterious material in layers, each 25 cm thick after rolling and of or CBR of 10% or more.				
2.3.1	Provide and lay sub base 30cm thick each layer. Price to include laying rolling to 95% optimum density after rolling the original ground to 95% optimum density.	m3	63.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 3 - CONCRETE WORKS				
3.1	**CAST IN PLACE CONCRETE** Cast in place concrete and concreting as specified and detailed, installed complete; INCLUDING for formwork and shuttering, including rebates, chamfers, grooves, mortices, block-outs, openings and the like; reglets, ties, water stops and other inserts; expansion, control and construction joints; basic formed finishes and unformed surface finishes; and all other related ancillaries as indicated or required Plain concrete; Class C; ordinary Portland cement (Type I)				
3.1.1	Blinding beds- including isolated, raft, strip footing foundations (10cm) Reinforced concrete; Class A; sulphate resisting cement (Type V) Supply, cast, and vibrate reinforced concrete forms and works to include: formworks, steel reinforcement, watering and curing the concrete, cylinder samples and testing and to satisfy the required strength as specified, and insulation as required. Contractor to submit shop drawings and attain engineer's approval prior to commencement of works	m3	18.00		0.00
3.1.2	Foundations; including bases, footings tie beams isolated, raft, connections, foundations, etc…… (40 cm) Supply, cast, and vibrate reinforced concrete forms and works to include: form works, steel reinforcement, watering and curing the concrete, cylinder samples and testing and to satisfy the required strength as specified, and insulation as required. Contractor to submit shop drawings and attain engineer's approval prior to commencement of works	m3	64.00		0.00
3.1.3	Concrete Columns	m3	14.00		0.00
3.1.4	Parapets Supply, cast, and vibrate reinforced concrete forms and works to include: form works, steel reinforcement, watering and curing the concrete, cylinder samples and testing and to satisfy the required strength as specified, and insulation as required. Contractor to submit shop drawings and attain engineer's approval prior to commencement of works	m3	5.00		0.00
3.1.5	Drop beams and drop panels	m3	7.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
3.1.6	Suspended SOLID slabs; embedded beams and upstand Supply, cast, and vibrate reinforced concrete forms and works to include: form works, steel reinforcement, watering and curing the concrete, cylinder samples and testing and to satisfy the required strength as specified, and insulation as required. Contractor to submit shop drawings and attain engineer's approval prior to commencement of works				
3.1.6.1	200 mm thick overall	m3	25.00		0.00
3.1.7	Steel bar reinforcement as specified and detailed, installed complete; INCLUDING scheduling; cutting, bending, fabricating, lapping and splicing; chairs, spacers and supports; and all other related ancillaries as indicated or required				
3.1.7.1	High tensile steel bars; all diameters cost is included in cost of reinforce concrete item 3.1.1, 3.1.2, 3.1.3, 3.1.4 and 3.1.5)	Kg	0.00		0.00
3.1.7.2	Mild steel bars; all diameters cost is included in cost of reinforce concrete item 3.1.1, 3.1.2, 3.1.3, 3.1.4 and 3.1.5)	Kg	0.00		0.00
3.1.7.3	Slab on grade (200 mm)	m3	15.00		0.00
3.1.7.4	Tranch (walls + Concrete cover)	m3	10.00		0.00
	Sundries Liquid applied waterproofing to concrete surfaces, as specified; including for substrate preparation, primer, protection, etc; and all other related ancillaries as indicated in the design drawings.				
3.1.8	Bituminous emulsion waterproofing paint to all concrete works in tack with the soil including all details as shown in the design drawings	m2	357.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 4 - MASONRY				
4.1	**UNIT MASONRY**				
	Hollow concrete (light weight) unit masonry as specified and detailed, installed complete; INCLUDING for joint and steel bar reinforcement, grout filled cells, wall ties and anchors; cutting. bonding and forming openings; precast or cast in place concrete lintels and cills; closures, control joints and weepholes; and all other related ancillaries as indicated or required.				
	Walls and partitions:				
4.1.1	100 mm thick	m2	130.00		0.00
4.1.2	150 mm thick	m2	130.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 5 - METALWORK				
5.1	Security Doors and Windows as shown on drawings Steel plate with Transom security door, window panel and fixed louver unit assemblies; fabricated and installed complete; INCLUDING for frames, hardware, operating devices, thresholds, trim and accessories				
5.1.1	Type S01 (300 cm x 280 cm) with upper louver (300 × 100)	No	4.00		0.00
5.1.2	Type S02 (100 cm x 220 cm)	No	2.00		0.00
5.1.3	Type S03 (200 cm x 220 cm)	No	2.00		0.00
5.1.4	Type S04 (180 cm x 220 cm)	No	1.00		0.00
5.1.4	Type S05 (90 cm x 190 cm)	No	1.00		0.00
5.2	**Ladders**				
5.2.1	For top of roof	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 7 - THERMAL AND MOISTURE PROTECTION				
7.1	**SHEET WATERPROOFING** Sheet waterproofing membranes as specified and detailed, installed complete; INCLUDING for substrate preparation, primers and adhesives; joint laps, coatings, flashings and accessories; and all other related ancillaries as indicated or required				
7.1.1	Polyethylene sheet; vapour barrier, under concrete ground slabs	m2	120.00		0.00
7.2	**POLYURETHANE WATERPROOFING FOR WET AREAS (PU)**				
7.2.1	Polyurethane painting waterproofing (PU); including for all preperation works and related ancillaries. - Cleaning the places - Apply Base coat - Apply two layers of PU paint include 20cm vertical high - The work should be executed by an expert - All needed works as per the Engineer instructions				
	Wet rooms including upstand at floor perimeter, shower rooms, toilets, kitchen, etc..	m2	4.00		0.00
7.3	**MEMBRANE ROOFING** SBS modified bituminous membrane roofing and deck assemblies as specified and detailed, installed in according to manufacturer instructions; INCLUDING for substrate preparation, primers, bonders, beds, fasteners and fixings; jointing and finishing; and all other related ancillaries as indicated or required.				
7.3.1	Roofing comprising: Lightweight concrete roof screed; Single layer modified bituminous membrane; (4mm thick) Protection sheet layer; 7cm graveling	m2	440.00		0.00
7.3.2	Membrane upstand; including cant strip, Aluminum flashing and mastic joint sealant	m	130.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 8 - DOORS AND WINDOWS **METAL DOOR FRAMES**				
8.1	**ALUMINIUM DOORS AND WINDOWS** Aluminium framed door, window, entrance, partition and screen units as specified and detailed, installed complete; INCLUDING for sub-frames, transoms and mullions; glass, glazing and aluminium louvres; supports, anchors, fasteners and fixings; protective coatings and sealants; hardware, ironmongery, accessories and trim; and all other related ancillaries as indicated or required on drawings. - (All aluminum section should be as manifacture by Technal Gx. Fx and all accessories should be stamped TECHNAL 100%) NOTE: All aluminium panels in all typical floors are double glazed. (Refer to drawings) Type:				
8.1.1	W-01 (Similar to the existing)	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 9 - FINISHES				
9.1	**LATH AND PLASTER**				
	Plaster and plastering as specified and detailed, installed complete; INCLUDING for substrate preparation, bonding and dubbing out; plaster lath, corner beads and other accessories, jointing and finishing; and all other related ancillaries as indicated or required. Refer to drawing.				
	Portland cement plaster, 20mm thick; internal				
9.1.1	General surfaces: walls and ceilings for internal space, including columns with the corner beads, beams, etc; margins, reveals and soffits	m2	420.00		0.00
	Portland cement plaster, 20mm thick; external render				
9.1.2	Walls generally; including margins, reveals and soffits; grooving as indicated	m2	200.00		0.00
9.1.3	Repair existing plaster on the internal and external façade wall installed complete,including for substrate preparation bonding and budding out and other accessories jointing and finishing and other related ancillaries as indicated or required	L.S	1.00		0.00
9.2	**CERAMIC WALL AND FLOOR TILE**				
	Ceramic tiles and tilework as specified and detailed, installed complete; INCLUDING for substrate preparation, cement sand screeds or plaster backing coats; setting, jointing and grouting; tile trim and accessories; sealants; and all other related ancillaries as indicated or required				
	Floors				
9.2.1	Ceramic tile; 400 x 400 mm	m2	300.00		0.00
9.2.1	300x300x8.5mm Non-glazed (Non-Slip) Full mass	m2	2.50		0.00
	Walls				
9.2.3	Glazed ceramic tile	m2	13.00		0.00
	Skirting Tiles				
9.2.2	ceramic tiles (h=150mm)	m2	21.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
9.3	**PAINTING** Finish paint and painting, complete as specified and detailed; INCLUDING for surface preparation, rubbing and puttying, (Minimum 3 layers putty) primers, undercoats, finish coats; and all other related ancillaries as indicated or required to:				
9.3.1	Interior Surfaces Walls and Ceiling, emulsion finish	m2	880.00		0.00
9.3.2	Exterior surfaces	m2	275.00		0.00
	Carried To Summary				**0.00**

10.1	**TOILET ACCESSORIES** Toilet accessories as specified and detailed, installed complete; INCLUDING for inserts, anchorages, fasteners and fixings; finishes, trim and tools; and all other related ancillaries as indicated or required.				
10.1.1	Toilet paper roll holder	No	1.00		0.00
10.1.2	Soap dispenser	No	1.00		0.00
10.1.3	Paper towel box/dispenser	No	1.00		0.00
10.1.4	Towel rail	No	1.00		0.00
10.1.5	Mirror unit; 800 x 600mm high	No	1.00		0.00
	Carried To Summary				**0.00**

PART 1

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

CHAPTE	SUMMARY				
1	SITE PREPARATION				0.00
2	EXTERNAL WORKS				0.00
3	CONCRETE WORK				0.00
4	MASONRY				0.00
5	METALWORK				0.00
7	THERMAL AND MOISTURE PROTECTION				0.00
8	DOORS AND WINDOWS				0.00
9	FINISHES				0.00
10	TOILET ACCESSORIES				0.00
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS CARRIED TO PRICE SUMMARY					**0.00**

REHABILITATION OF MAIN ELECTRICAL ROOM / NEW GENERATORS ROOM IN RESIDENTIAL PALACE - PHASE 2

PART-2
MECHANICAL ENGINEERING SERVICES

Item	Description	Unit	Quantity	Unit Rates US.S	Amount US.$.
	CHAPTER 1 - GENERAL TECHNICAL REQUIREMENTS				
1.1	All works shall comply with the general technical requirements sections of the specification including: Compliance with applicable laws, regulations, codes & standards General installation requirements Scope regulations and standards. Electrical Services installation. Noise and vibration control. Power and Control of mechanical equipment Spare parts as recommended by the manufacturer Preparation of shop drawings Preparation of as built drawings Inspection testing and commissioning. Handover procedures and documentation. Operation and maintenance manuals Training for client / maintenance staff Warranty and defects liability requirements Maintenance, Responsibility & Acceptance Temporary works and protection				
1.1.1	All above	item	1.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
1.2	**Dismantling and removal of existing mechanical equipment** Dismantle, disconnect, remove all existing mechanical equipment indicated on the drawings or instructed by the engineer. All equipment shall be handled without damage and delivered to the client's designated storage area or handed over to the client's representative. The contractor shall dispose of only those materials specially approved by the engineer and shall make good any damage resulting from the removal works.				
1.2.1	External louvers	item	1.00		0.00
1.2.2	Fans	item	1.00		0.00
1.2.3	DX split unit	item	1.00		0.00
1.2.4	Electric water heater	item	1.00		0.00
1.2.5	Sanitary fixtures + accessories	item	3.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 3 - SANITARY, LABORATORY, VENT, WASTE AND RAINWATER PIPEWORK INSTALLATION				
3.1	**SANITARY WASTE, RAIN WATER & VENT PIPE WORKS** Supply, install, test and commission sanitary waste, rain water, and vent pipe work complete with all required fittings, supports, openings, sleeves, sealants, cleanouts, and accessories for a fully functional installation in accordance with the specifications, drawings and applicable regulations and standards				
3.1.1	**UPVC pipes & fitting;**				
3.1.1.1	Ø 50mm (MUPVC)	m	15.00		0.00
3.1.1.2	Ø 75mm	m	11.00		0.00
3.1.1.3	Ø 110mm	m	4.00		0.00
3.2	**ROOF VENT CAP** Supply, install, test and commission roof vent cap including fixation with PVC pipe and all required accessories for a fully functional installation in accordance with the specifications, drawings and applicable regulations and standards				
3.2.1	RVC - 01 (Ø50 mm)	No	1.00		0.00
3.3	**AREA DRAINS** Supply, install, test and commission area drains include all necessary supports, flashings, strainers, built-in bad smell barrier, connection with all needed materials and all required accessories for a fully functional installation in accordance with the specifications, drawings and applicable regulations and standards				
3.3.1	**FD-01 (PVC or Stainless Steel Chrome plated Floor Drain Cover)**				
3.3.1.1.	Ø 75 mm Side Outlet (Body + Cover) 200 x 200 mm	No	1.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
3.3.2	**JB-01(PVC OR STAINLESS-STEEL CHROME PLATED JUNCTION BOX COVER)**				
3.3.2.1	200 x 200 mm PVC + Cover	No	1.00		0.00
3.4	**RAIN WATER AREA DRAINS** Supply, install, test and commission rain water area drains (dome type) including elevated dome strainer, flashing clamp collar, integral gravel guard, outlet connections to rain water gutters/down pipes, fittings and all required accessories for a complete and fully functional installation in accordance with project specifications, drawings and applicable regulations and standards				
3.4.1	RD-Ø75mm	No	2.00		0.00
3.4.2	Rehabilitation & cleaning of the existing roof drains including all required works for a fully functional installation in accordance with the applicable standards and regulations	item	6.00		0.00
	Carried To Summary				**0.00**

4.1	**CHAPTER 4 - PIPED SYSTEMS (LIQUIDS)** **DOMESTIC HOT AND COLD WATER** Supply, install, test and commission domestic hot and cold water, pipework include all fittings bends, tees, elbows, vents and drains well, valves, expansion joints, flexible connections, sleeves, joints, openings, sealants, supports, brackets and hangers and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards.				
4.1.1	**Cold/hot water polypropylene PN20/25 SDR-6 confirm to DIN 8077/8078 or approved equal** **Multi-Layer PPR with Fiber (Internal Installations)**				
4.1.1.1	ø 20mm	m	17.00		0.00
4.1.1.2	ø 25mm	m	3.00		0.00
4.1.1.3	ø 32mm	m	2.00		0.00
4.1.2	**ANGLE VALVES** Supply, install, test and commission angle valves, include all required accessories/connections for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
4.1.2.1	ø 20mm angles valves	No	3.00		0.00
4.2	**ELECTRICAL WATER HEATER** Supply, install, test and commission Electrical Water Heater include pipe work connections, drain connections to the nearest drain, temperature and pressure gauges, controls and power wiring from control panel, controls and high limit control valves, isolation and safety valves, thermal insulation, LED indicator for ON/OFF indication, disconnect switches, and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards Electrical water heater degree of protection shall not be less than IP55				
4.2.1	EWH-100 L (1.5 KW @1Ph)	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 6 - FUEL OIL TANK				
6.1	**FUEL OIL TANK** Supply, install, test and commission, fuel oil storage tank include oil fill points, control wiring, valves, anti-vibration flexible connections, fittings, drain valve, overflow, medium duty cover, level indicator, relief venting, level switch, flame arrestor, and all required accessories and civil works for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards. Main black steel tank degree of protection shall not be less than IP 68				
6.1.1	2.4 m x 1.2 m x 2.4 m black steel tank (4mm thickness) chassis at 0.6 m above FFL on steel scaffolding columns	No	1.00		0.00
6.2	**FILL CABINET** Supply, install, test and commission fill oil cabinet, include coupling, valves, check valve, LED level indicator connected to level switch sensor via control wiring and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
6.2.1	All above	No.	1.00		0.00
6.3	**FUEL OIL PIPEWORKS** Supply, install, test and commission Fuel oil pipeworks; include valves, connections to generators, all pipes double wrapped in protective tape running in trenches or where buried, fittings, hangers, supports and brackets and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulation and standards				
6.3.1	Ø 25 mm (Seamless black carbon steel)	m	21.00		0.00
6.3.2	Ø 32 mm (Seamless black carbon steel)	m	15.00		0.00
6.3.3	Ø 50 mm (Seamless black carbon steel)	m	51.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
6.4	**SOLENOID VALVE** Supply, install, test and commission solenoid shut off valve (normally open) interlocked with fire alarm via control module, include pipes connections, fittings, valves, control wiring, and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards.				
6.4.1	ø 50 mm Solenoid valve	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 8 - AIR CONDITIONING AND VENTILATION INSTALLATION				
8.1	**DUCT WORK AND ACCESSORIES**				
8.1.1	**DUCT WORKS**				
	Supply, install, test and commission galvanized steel ducting for ventilation system, include flexible connections, supports, hangers and brackets, opening, sleeves and sealants, fittings, safety and fire-rated installation vibration isolators, anchor bolts, connections to fans and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
8.1.1.1	G90 confirm to ASTM A653/Z275 confirm to EN 10346 duct works	Kg	100.00		0.00
8.1.1.2	PVC duct Ø150mm	m	5.00		0.00
8.1.2	**MOTORIZED FIRE DAMPERS MFDR**				
	Supply, install, test and commission motorized fire dampers (normally open) interlocked with fire alarm, include supports and brackets, sealing and air-tightness fixation, control module and control wiring, actuation and related connections, safety and fire-rated installation, and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
8.1.2.1	900 x 1900 mm, MFDR	No	1.00		0.00
8.1.2.2	2000 x 2200 mm, MFDR	No	2.00		0.00
8.1.2.3	2800 x 1000 mm, MFDR	No	4.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
8.1.3	**EXHAUST PIPES OF GENERATOR** Supply, install, test and commission exhaust seamless black steel pipes confirm to ASTM A53/A106 schedules 40, grade B or approved equal, include connection to generator, fittings, muffler silencer acoustic insulation complete with spark arrestor and flexible connector, Diesel oxidation catalyst filtration unit suitable for 500/725 KVA generator operation, hangers, supports & brackets, cleanout, and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
8.1.3.1	Ø 250 mm (4mm thickness)	m	24.00		0.00
8.1.3.2	Ø 300 mm (4mm thickness)	m	8.00		0.00
8.2	**AIR OUTLETS** Supply, install, test and commission air outlets, include mounting and supports, sealing and airtightness fixation, safety and fire- rated installation, duct connections, air flow control, finishing and alignment, and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
8.2.1	**AIR LOUVERS (FAL + Filter)**				
8.2.1.1	900 × 1900 mm	No	1.00		0.00
8.2.1.2	2000 × 2200 mm	No	2.00		0.00
8.2.1.3	2800 × 1000 mm	No	4.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
8.3	**FANS** Supply, install, test and commission fans include ductwork connections via flexible connectors, isolator switches, power and control wiring to the control panel, temperature sensors & controllers, attenuators, acoustic cladding to duct connections, identification and bonding, hangers, supports and brackets and all required accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
8.3.1	EXF-75 Cfm @ 30pa (wall mounted)	No	1.00		0.00
8.3.2	EXF-3400 Cfm @ 65pa (floor mounted)	No	1.00		0.00
8.4	**DX SPLIT UNITS** Supply, install, test and commission DX split air conditioning units complete, including indoor and outdoor units, refrigerant piping, insulation, condensate drain pipes connections, control wiring, interconnecting power and control cables, wall brackets and/or supports, vibration isolators, refrigerant gas charging, pressure testing, vacuuming, electrical connections, disconnected switches, thermostat remote, and all required accessories for a fully functional installation in compliance with drawings, specifications and applicable regulations and standards				
8.4.1	IU (DX)/OU (DX) -2.0 (ceiling suspended) 2TR Cooling capacity- Inverter type 850 Cfm air flow	No	2.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
8.5	**CONDENSATE DRAIN PIPES** Supply, install test & commissioning pressure PVC (PPVC) Condensate drain pipe, including pipes & fittings manufactured in accordance with BS EN 1452 or equivalent approved standard, minimum pressure rating PN10, solvent cement jointing, supports and hangers, sleeves through walls/slabs, proper slope , connection to indoor units and approved discharge point, leakage testing, and all required accessories for a fully functional installation in compliance with drawings, specifications, and applicable standards and regulations				
8.5.1	ϕ32mm	m	2.00		0.00
8.5.2	ϕ50mm	m	6.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 9- FIRE PROTECTION				
9.1	**AUTOMATIC FIRE SUPRESSION FM-200**				
	Supply, install, test and commission for Automatic FM-200 fire suppression system, complete with nozzles, detectors, control panel dedicated for the suppression system, control cables, red light and sound alarm signal, valves, manifold, black steel piping, supports, brackets and hangers and all necessary accessories for a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
9.1.1	3 × 45 Kg Floor mounted cylinders	item	1.00		0.00
9.1.2	7 × 45 Kg Floor mounted cylinders	item	1.00		0.00
9.2	**PORTABLE FIRE EXTINGUISHER**				
	Supply, install, test and commission for Portable Fire Extinguisher complete with supports, brackets, hangers, and all necessary accessories or a fully functional installation in accordance with the specifications, drawings, and applicable regulations and standards				
9.2.1	PFE - 6 Kg ABC dry chemical powder	No	8.00		0.00
9.2.2	PFE - 5 kg (CO_2)	No	6.00		0.00
9.2.3	PFE- 6L (Foam type)	No	1.00		0.00
9.3	**FIRE INTUMESCENT MATERIAL**				
9.3.1	Provide and installation all fire instumescent insulation materials & components as specified, detailed & necessary required, (including but not limited to openings & penetration through fire rated enclosures at mechanical shafts, ducts, sleeves), complete with supports, anchors and fasteners, mastic sealer; and all other related ancillaries as required for complete installations	L.S.	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 11 - THERMAL INSULATION AND IDENTIFICATION OF SERVICES Supply, install, test and commission thermal insulations, include adhesive application, mechanical fixings, vapor barriers, and protective or decorative finishes. Works, shall also include proper identifications and labeling of services, sealing of joints, and ensuring all insulation materials meet the required thickness, density, and fire/ safety standards for a fully functional installations in accordance with the specifications, drawings, and applicable regulations and standards				
11.1	**THERMAL INSULATION WITH ALUMINUM JACKETING FOR EXHAUST STEEL OF STEL OF GENERATOR**				
11.1.1	Miniral/Rock Wool insulation 50 mm thickness, 80-120 Kg/m³ density	m	32.00		0.00
11.2	**THERMAL INSULATION FOR HOT WATER PPR PIPES**				
11.2.1	Closed- cell elastomeric rubber type, 13 mm minimum thickness, 45 kg/m³ minimum density	m	9.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 12 - AUTOMATIC CONTROLS AND MONITORING INSTALLATION				
12.1	**MOTOR CONTROL CENTER**				
	(Refer to Electrical BOQ)				
12.2	**CONTROL PANEL**				
	Supply, install, test and commission control panel dedicated for exhaust fans including: - Main circuit breaker: 4×16A - Circuit Breaker: 2×10A for each fan - Contactor + protection for each fan - Selector 3 - positions: manual / off / Auto for each fan - Indication LED light On/Off operation or each fan - Power cable: 2×4 mm² + E = 4 mm² for each fan - Controller + relay + temperature sensor for each fan including control cables.				
12.2.1	CP-01 (included in phase 1)	item	0.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 13 - SANITARY FIXTURES Supply, install test and commission sanitary fixtures manufactured from vitreous China or approved equivalent including mixers, chrome plated traps, pop-up drain, drain connections, cold/hot water connections, flushing system, fixing brackets & supports, sealants, testing for leakage, and all necessary accessories required for a complete & fully functional installation in compliance with drawings, specifications and applicable standards & regulations				
13.1	**LAVATORIES**				
13.1.1	LAV-01 (Semi Pedestal) Estimated dimenisons 55 × 50 cm	item	1.00		0.00
13.2	**WATER CLOSETS**				
13.2.1	EWC-01 (flush tank floor-mounted) complete with flushing hoses Estimated dimenisons 65 × 36 cm	item	1.00		0.00
13.3	**SHOWER** Supply and installation of complete shower set comprising chrome - plated shower head and single - lever mixer, including all necessary fittings and accessories, complete in place				
13.3.1	SH-01	item	1.00		0.00
	Carried To Summary				**0.00**

PART-2	**MECHANICAL ENGINEERING SERVICES**				
Chapter	**SUMMARY**				
1	GENERAL TECHNICAL REQUIREMENTS				0.00
3	SANITARY, LABORATORY, VENT, WASTE AND RAINWATER PIPEWORK INSTALLATION				0.00
4	PIPED SYSTEMS (LIQUIDS)				0.00
6	FUEL OIL TANK				0.00
8	AIR CONDITIONING AND VENTILATION INSTALLATION				0.00
9	FIRE PROTECTION				0.00
11	THERMAL INSULATION AND IDENTIFICATION OF SERVICES				0.00
12	AUTOMATIC CONTROLS AND MONITORING INSTALLATION				0.00
13	SANITARY FIXTURES				0.00
MECHANICAL ENGINEERING SERVICES TOTAL CARRIED TO PRICE SUMMARY					**0.00**

REHABILITATION OF MAIN ELECTRICAL ROOM / NEW GENERATORS ROOM IN RESIDENTIAL PALACE - PHASE 2

PART-3
ELECTRICAL ENGINEERING SERVICES

Item	Description	Unit	Quantity	Unit Rates US.S	Amount US.$.
	CHAPTER 1 - DISTRIBUTION BOARDS AND CIRCUIT BREAKERS				
1.1	**SECONDARY DISTRIBUTION BOARDS** Supply, install, connect and test the following secondary boards in perfect operation conditions as shown on drawings and specified inclusive of enclosure, all bus bars, protective devices, all necessary components and requirements of command and monitoring controls local, and should be interfaced with BMS, and the like as intended to the satisfaction of the engineer Contractor shall submit full shop drawings regarding all below boards including single live diagram, external view, internal connection view, bill of quantities for each panel to satisfaction of Supervisor Engineer.				
1.1.1	R1- panel	No	1.00		0.00
1.1.2	R2- panel	No	1.00		0.00
1.1.3	R3- panel	No	1.00		0.00
1.1.4	R4- panel	No	1.00		0.00
1.1.5	DB-B	No	1.00		0.00
1.1.6	DB-R.3	No	1.00		0.00
1.1.7	DB-G	No	1.00		0.00
1.1.8	Junction Box R3	No	1.00		0.00
1.1.9	Junction Box R4	No	1.00		0.00
1.1.10	Blue Panel (as named on site)	No	1.00		0.00
1.2	**MANUAL TRANSFER SWITCHES** Supply, install and test the manual transfer switches (MTS) in perfect operating conditions as shown in the drawings and the pecific inclusive of enclosure, bus bars, closet all the necessary components and the like to the satisfaction of the engineer, with three position switch (1;0;2), the MTS should be interfaced with BMS				
1.2.1	MTS-EDL/EDL (4×2500A)	No	1.00		0.00
	Carried To Collection				**0.00**

	From Collection				**0.00**
1.3	**AUTOMATIC TRANSFER SWITCHES** Supply, install and test the automatic transfer switches (ATS) in perfect operating conditions as shown in the drawings and the pecific inclusive of enclosure, bus bars, closet all the necessary components and the like to the satisfaction of the engineer, with three position switch (1;0;2), the ATS should be interfaced with BMS				
1.3.1	ATS-1 EDL/GEN (4x2500A)	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 2 - CABLES AND WIRES **FEEDER CABLES** Supply, install, connect and test the following PVC and XLPE insulated cables, including trenches with covers, pipes, sleeves, cable trays, cable ladders, tagging, glands, terminations and the like for a complete installation as shown on drawings and as intended to the satisfaction of the engineer				
2.1	**CU/XLPE/SWA/PVC CABLES (Multi Core Cables)**				
2.1.1	4C x 240 mm2	m	271.00		0.00
2.1.2	4C x 150 mm2	m	36.00		0.00
2.1.3	4C x 120 mm2	m	24.00		0.00
2.2	**XLPE/PVC/CU CABLES (Multi Core Cables)**				
2.2.1	4C x 25 mm2	m	192.00		0.00
2.2.2	4C x 16 mm2	m	24.00		0.00
2.3	**PVC/CU/PVC CABLES (Multi Core Cables)**				
2.3.1	4C x 6 mm2	m	80.00		0.00
2.4	Provision for cable trays blending and termination kits	L.s	1.00		0.00
2.5	Disconnect the existing cables within the main electrical room, associated with the chillers system, then reinstall and connect them to the designated circuit breaker in the MDB-2 panel including all necessary works in accordance with the instructions of the supervising engineer	L.s	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 3 - WIRING DEVICES, SWITCHES, SOCKETS, ETC				
3.1	**DISCONNECTING SWITCHES**				
	Supply, install, connect and test disconnecting switches complete in perfect operating conditions; including conduits; trays, trenches, boxes, wiring, wiring cable (measured separately) and the like to the satisfaction of the engineer				
3.1.1	2x16A 2pole (IP=65)	No	3.00		0.00
3.2	**ELECTRICAL DEVICES/ACCESSORIES**				
	Supply, install, connect and test wiring devices complete in perfect operating conditions, including conduits, trays, trenches, boxes, wiring,(up to panel boards or to nearest wiring device or lighting fixture) for all items listed below and the like to the satisfaction of the engineer				
	Switches				
3.2.1	One way one gang lighting switch, 10A rated	No	2.00		0.00
3.2.2	One way Two gang lighting switch, 10 A. rated	No	2.00		0.00
3.2.3	One way Three gang lighting switch, 10 A. rated waterproof	No	1.00		0.00
3.2.4	Two way Two gang lighting switch, 10 A. rated	No	4.00		0.00
3.3	**Sockets**				
3.3.1	16 AMP SIMPLEX -2P+E	No	7.00		0.00
3.4	**Electrical Outlet**				
3.4.1	Electrical outlet for fan	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 4 - GROUNDING AND BONDING Supply, install, connect and test, complete in perfect operating conditions, including earth pits, earth test links, earth bar, earth continuity conductor to all panels in compliance with international regulations including interconnection of all earthing systems and to the satisfaction of the Director of works				
4.1	Earthing for generators	L.s.	1.00		0.00
4.2	Earthing for MV switch gear and EDL transformer	L.s.	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 6 - LIGHTING INSTALLATION AND FITTINGS				
6.1	**LIGHTING POINTS** Supply and install the following points complete with all necessary wires conduits, boxes and accessories required to provide power to the lighting fittings from LP (lighting panel including earth wire all as described and as shown on drawings).				
6.1.1	Lighting points	No	59.00		0.00
6.2	**LIGHTING FITTINGS** Lighting fittings shall be complete with suspension/ LED rods, tubes, ballast's and accessories. LED fixtures shall have a power factor correction greater than 0.9 Supply and install the following lighting fittings.				
6.2.1	Type D1	No	1.00		0.00
6.2.2	Type F	No	1.00		0.00
6.2.3	Type O	No	5.00		0.00
6.2.4	Type C	No	36.00		0.00
6.2.5	Type C1	No	3.00		0.00
6.2.6	Exit - maintained 3 hours	No	4.00		0.00
6.2.7	Ceiling emergency light maintained 3 hours	No	12.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 9 - FIRE ALARM AND DETECTION				
9.1	**FIRE ALARM SYSTEM** Supply and install all necessary fittings, wires conduits, boxes, plates, relays, bell modules, EOL resistors and accessories as described and as shown on drawings and all necessary connection to the management stations as intended to the satisfaction of the engineer compatible to existing fire alarm system				
9.1.1	Waterproof flasher	No	2.00		0.00
9.1.2	Fire alarm manual break glass station	No	3.00		0.00
9.1.3	Fire alarm bell with strobe light	No	1.00		0.00
9.1.4	Heat detector H	No	4.00		0.00
9.1.5	Combined heat smoke detector SH	No	8.00		0.00
9.1.6	Control module	No	3.00		0.00
9.1.7	Testing and Commisioning for the new and old fire alarm devices and system	L.s.	1.00		0.00
	FIRE INSTUMESCENT MATERIAL Provide and installation all fire instumescent insultation materials & components as specified, detailed & necessary required, (including but not limited to openings & penetration through fire rated enclosures at electrical shafts, ducts, sleeves), complete with supports, anchors and fasteners, mastic sealer; and all other related ancillaries as indicated or required - Generator and mechanical rooms - shafts and electrical rooms. - Shafts and inverter room.	L.s.	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 10 - MEDIUM VOLTAGE 11 kV switchgear and Protection System including inspection, dismantling for existing bus bar and switches, cleaning, servicing. The work shall include circuit breaker, current and voltage transformer and protection relays and copper bus bar; the MV switchgear should be interfaced with BMS				
10.1	Switchgear with breakers (11 KV, 630 Amp one input and 3 output refer to dwg E405)	No	1.00		0.00
10.2	MV cable 3 × 70 mm²	L.m	18.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 11 - TRANSFORMER Supply, install, and connect transformer including LV and MV switch gear, including LV cables and all necessary terminations; the transformer should be interfaced with BMS				
11.1	Transformer 1600 KVA 11KV/380V	No	1.00		0.00
11.2	ACB with closet 4 x 2500 A	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 12 - ENGINE GENERATOR				
12.1	**GENERATOR** Provide emergency generator set complete as described including, breaker, accessories, controls, control panel, with canopy,daily fuel tank, main fuel tank, exhaust, muffler, supply and exhaust air ducts,electric and manual fuel pump and all ancillaries; the generator should be interfaced with BMS				
12.1.1	0.38 KV, 50 Hz, 500 KVA, 1500rpm, P.F=0.8 prime generator	item	3.00		0.00
12.1.2	Generators Totalizing Panel	item	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 14- PASSIVE SYSTEM COMMUNICATION Supply, install, connect, test, commission Multi-Service Network as per the drawings and specifications including all necessary equipment accessories, parts and services needed to provide Owner with state of the art network solution that is fully functioning. Horizontal Cabling The Contractor will be supply, install, connect only Infrastructure works Data, Telephone including cable trays, conduits and boxes				
14.1	SINGLE Outlet Including cable, trays, conduits, boxes for RJ45				
14.1.1	Single Data Wall Outlet RJ 45 (complete installation)	No	3.00		0.00
14.1.2	Single data wall outlet RJ45 (second fix)	No	2.00		0.00
14.1.3	Data Rack (9U)	No	1.00		0.00
14.1.4	Data Box	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 15 - TELEPHONE SYSTEM Supply, install and test telephone system with conduits installations from Telephone Box to the Telephone socket outlets, including pull or draw or junction boxes.				
15.1	Telephone outlet RJ 45 (complete installation)	No	2.00		0.00
15.2	Telephone outlet RJ 45 (second fix)	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 16-TELEVISION SYSTEM Supply, installm and test television system with conduits installations from TV box to TV outlets, including pull or draw or injuction boxes				
16.1	TV outlet	No	1.00		0.00
16.2	TV box	No	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 17-BUILDING MANAGEMENT SYSTEM (BMS) Supply, install, connect, testing and commissiong for a complete Building Management System (BMS) including integration programming. The system BMS used for monitoring and supervising of the main electrical room in the palace including cables, UPS, LCD, controllers, DDC's, power supply, communication devices, accessories and integration with the existing and new panels and all systems as mentioned in the drawings and specifications. The system must be able for future extension as per specifications requirements				
17.1	Complete BMS System	L.s.	1.00		0.00
	Carried To Summary				**0.00**

	CHAPTER 18 - EXTERNAL WORKS				
18.1	Excavation Trench 80x60 including steel cover and all necessary works (refer to drawings E-413)	L.m	40.00		0.00
18.2	Road crossing including 2x5x6 inch PVC conduit for cables from new genset	L.m	7.00		0.00
18.3	Dismantling and removing the existing 2 generators G3 600 KVA and G4 725 KVA	L.S.	1.00		0.00
18.4	During the renovation period G3 should be reinstalled and connected to the load to maintain continuity of service and complete operational functionality including all temporary works required	L.S.	1.00		0.00
18.5	Reinstalling, testing and commissioning for existing generator G4 725 KVA, removing and handlingG3 to the representative of the presidential palace	L.S.	1.00		0.00
18.6	Dismantling and reinstalling of existing panels and cables as required and reconnect all existing circuits and cables to the new panel including testing and commissioning. Removing and handling for all panel and cable not used to the representative of the palace	L.S.	1.00		0.00
18.7	Dismantling and reisntalling of existing transformers and cables as required and reconnected all existing circuit and cables to the new panels, including testing and commissioning. Removing and handling for old transformer not used to the representative of the palace.	L.S.	1.00		0.00
18.8	Unseen works	L.S.	1.00		0.00
	Carried To Summary				**0.00**

	ELECTRICAL ENGINEERING SERVICES				
	SUMMARY				
1	DISTRIBUTION BOARDS AND CIRCUIT BREAKERS				0.00
2	CABLES AND WIRES				0.00
3	WIRING DEVICES, SWITCHES, SOCKETS, ETC				0.00
4	GROUNDING AND BONDING				0.00
6	LIGHTING INSTALLATION AND FITTINGS				0.00
9	FIRE ALARM AND DETECTION				0.00
10	MEDIUM VOLTAGE				0.00
11	TRANSFORMER				0.00
12	GENERATORS				0.00
14	PASSIVE SYSTEM COMMUNICATION				0.00
15	TELEPHONE SYSTEM				0.00
16	TELEVISION SYSTEM				0.00
17	BMS System				0.00
18	EXTERNAL WORKS				0.00
	ELECTRICAL ENGINEERING SERVICES TOTAL CARRIED TO PRICE SUMMARY				**0.00**

LIST OF DRAWINGS

ARCHITECTURAL

DRAWING	TITLE
A–000	COVER
A–001	LIST OF DRAWINGS
A–110	MAIN ELECTRICAL ROOM–TRANSFORMER GOOGLE MAP
A–111	MAIN ELECTRICAL ROOM–TRANSFORMER EXISTING LAYOUT
A–112	MAIN ELECTRICAL ROOM–TRANSFORMER PROPOSAL LAYOUT
A–113	MAIN ELECTRICAL ROOM–TRANSFORMER ROOF LAYOUT
A–114	NEW GENERATOR ROOM–PLAN
A–115	NEW GENERATOR ROOM– ROOF PLAN
A–116	NEW GENERATOR ROOM– ELEVATION
A–117	NEW GENERATOR ROOM– ELEVATION
A–118	NEW GENERATOR ROOM– SECTION
A–119	MAIN ELECTRICAL ROOM – STEEL SCHEDULE

MECHANICAL

DRAWING	TITLE
M–301	GENERAL MECHANICAL DETAILS
M–302	SCHEDULES OF EQUIPMENT AND CALCULATION NOTES
M–303	GROUND FLOOR PLAN –DRAINAGE AND STORM LAYOUT
M–304	ROOF FLOOR PLAN –DRAINAGE AND STORM LAYOUT
M–305	GROUND FLOOR PLAN –WATER SUPPLY LAYOUT
M–306	GROUND FLOOR PLAN –FIRE FIGHTING LAYOUT
M–307	GROUND FLOOR PLAN –FUEL OIL LAYOUT
M–308	GROUND FLOOR PLAN –HVAC LAYOUT
M–309	ROOF FLOOR PLAN –HVAC LAYOUT

ELECTRICAL

DRAWING	TITLE
E–401	ELECTRICAL LEGEND
E–402	ELECTRICAL GENERAL DETAILS
E–403	ELECTRICAL CALCULATION REPORT
E–404	ELECTRICAL RISER DIAGRAM PHASE 2
E–405	MV RISER DIAGRAM
E–406	NEW PANEL BOARD 1/3
E–407	NEW PANEL BOARD 2/3
E–408	NEW PANEL BOARD 3/3
E–410	MAIN ELECTRICAL ROOM–TRANSFORMER EXISTING LAYOUT
E–411	MAIN ELECTRICAL ROOM–TRANSFORMER DEMOLISHING LAYOUT
E–412	MAIN ELECTRICAL ROOM–TRANSFORMER PROPOSAL LAYOUT
E–413	ELECTRICAL TRENCH LAYOUT
E–414	MAIN ELECTRICAL ROOM–TRANSFORMER LGT LAYOUT
E–415	MAIN ELECTRICAL ROOM–TRANSFORMER PWR LAYOUT
E–416	MAIN ELECTRICAL ROOM–TRANSFORMER LWC LAYOUT
E–417	MAIN ELECTRICAL ROOM–TRANSFORMER FIRE ALARM LAYOUT
E–418	MAIN ELECTRICAL ROOM–TRANSFORMER EARTHING SYSTEM
E–419	BUILDING MANAGEMENT SYSTEM (BMS)

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4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
LIST OF DRAWINGS

SCALE:	1/50
DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
SHEET SIZE A:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026–14	A–102
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-A102

ARCHITECTURAL DRAWINGS

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GENERAL DIRECTORATE BAABDA, LEBANON

MAIN ELECTRICAL / GENERATOR ROOMS

MAIN ELECTRICAL ROOM-TRANSFORMER GOOGLE MAP

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SCALE:	1/50
DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
SHEET SIZE: A1	
PROJ. No:	L2026-14
DWG. No:	A-002
APP'D FOR CONSTRUCTION :	

COMPUTER CODE No: | 1606-14-1000

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LEGEND

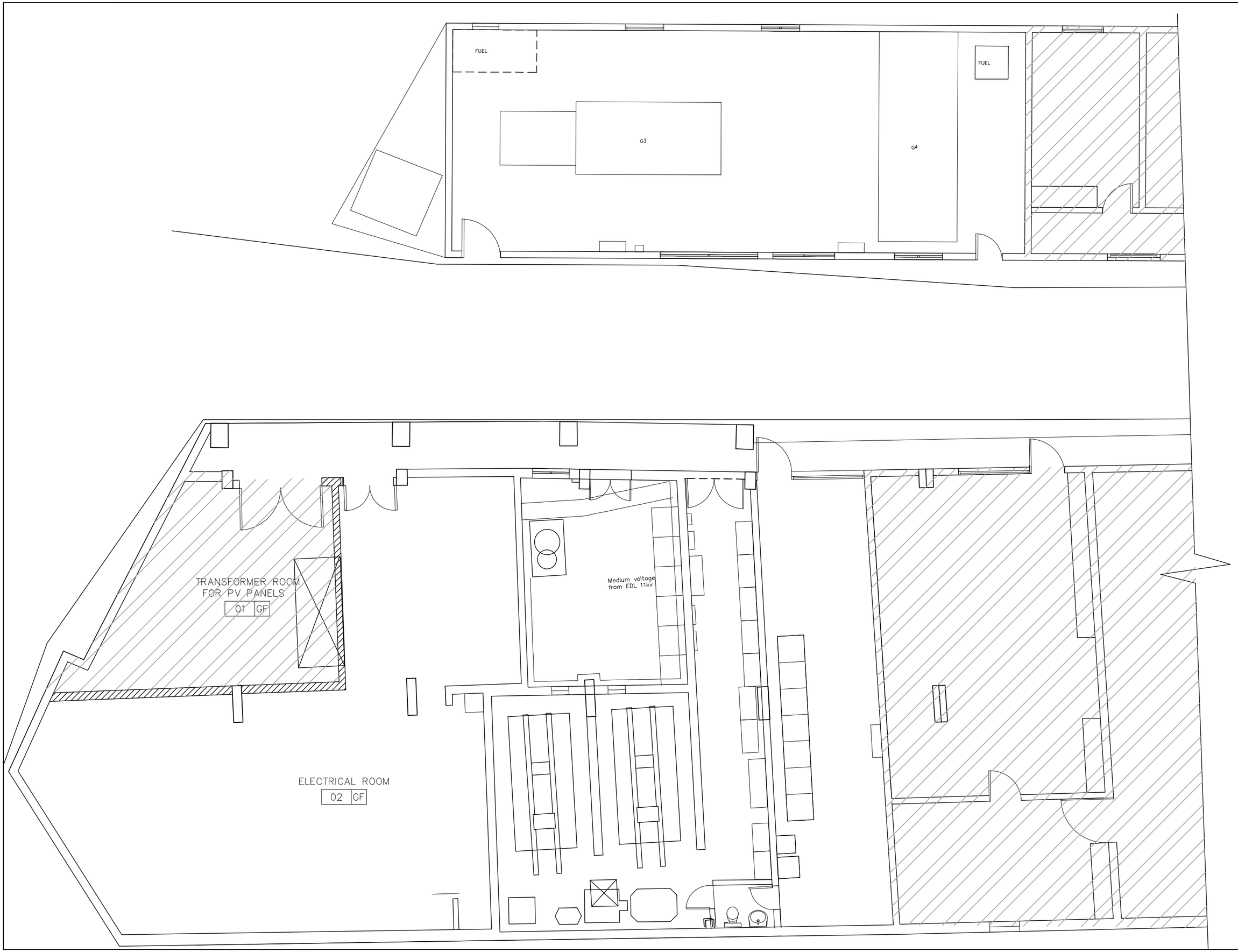
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Rev2	2 – XXXXX	X.X	X/XX/XX
Rev3	3 – XXXXX	X.X	X/XX/XX
Rev4	4 – XXXXX	X.X	X/XX/XX
Rev5	5 – XXXXX	X.X	X/XX/XX
Rev6	6 – XXXXX	X.X	X/XX/XX





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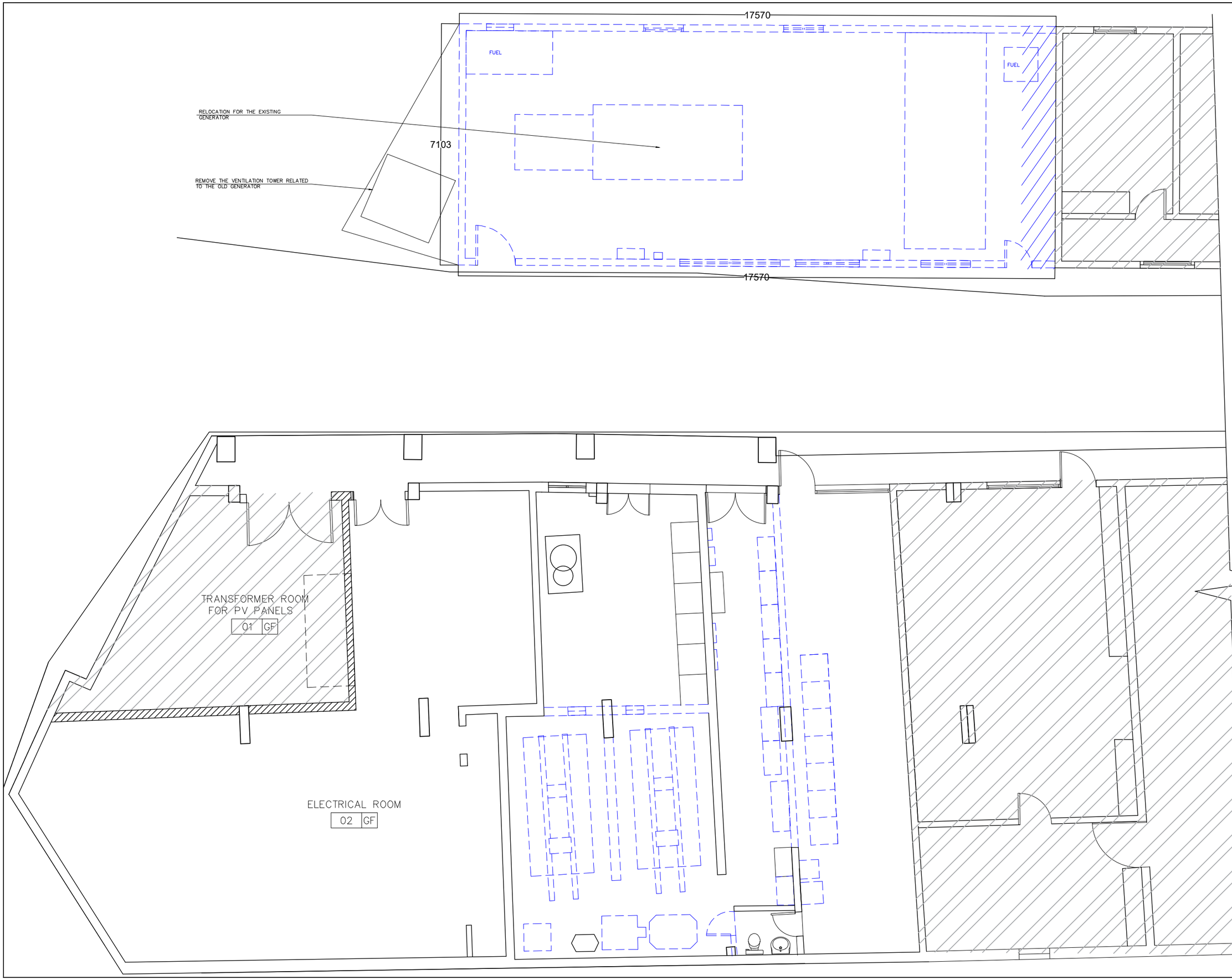
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GENERAL DIRECTORATE BAABDA, LEBANON

MAIN ELECTRICAL / GENERATOR ROOMS

MAIN ELECTRICAL ROOM-TRANSFORMER EXISTING LAYOUT

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DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
SHEET SIZE A:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026-14	A-110
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-A110



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4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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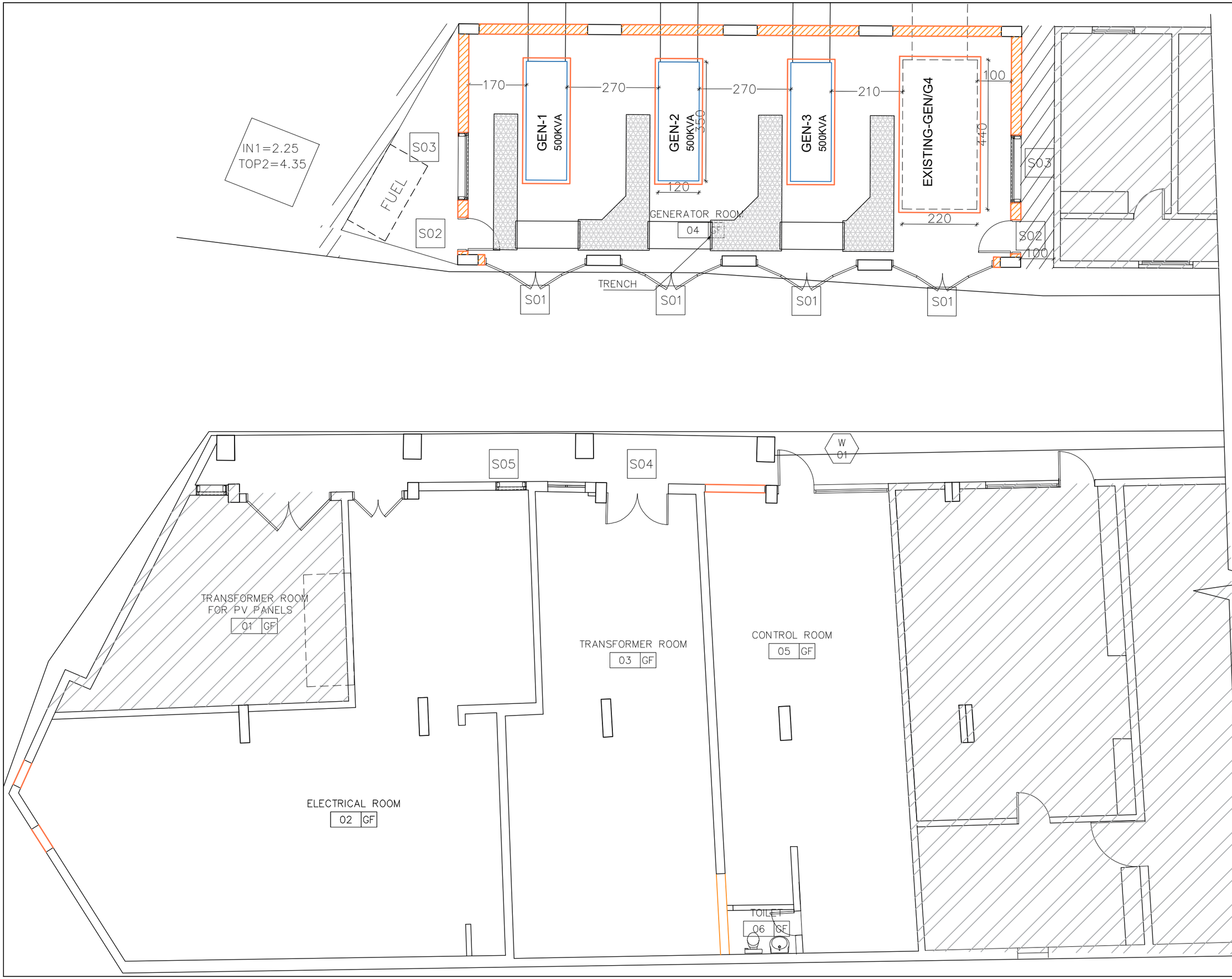
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GENERAL DIRECTORATE BAABDA, LEBANON

MAIN ELECTRICAL / GENERATOR ROOMS

MAIN ELECTRICAL ROOM-TRANSFORMER DEMOLISHING LAYOUT

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DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
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PROJ. No.:	DWG. No.:
L2026-14	A-111
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-A111



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Rev3	3 – XXXXX	X.X	X/XX/XX
Rev4	4 – XXXXX	X.X	X/XX/XX
Rev5	5 – XXXXX	X.X	X/XX/XX
Rev6	6 – XXXXX	X.X	X/XX/XX

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GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM-TRANSFORMER PROPOSAL LAYOUT

SCALE:	1/50
DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
SHEET SIZE A:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026-14	A-112
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-A112

PRESIDENTIAL PALACE

GENERAL DIRECTORATE BAABDA, LEBANON

MAIN ELECTRICAL / GENERATOR ROOMS

MAIN ELECTRICAL ROOM-TRANSFORMER ROOF LAYOUT

SCALE: 1/50
DATE: SEP. 2026
DRAWN: N.D
CHECKED: A.M.
APP'D: A.M.
SHEET SIZE: A1
PROJ. No: L2026-14
DWG. No: A-113
APP'D FOR CONSTRUCTION :

COMPUTER CODE No: L2026-14-113

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NOTES

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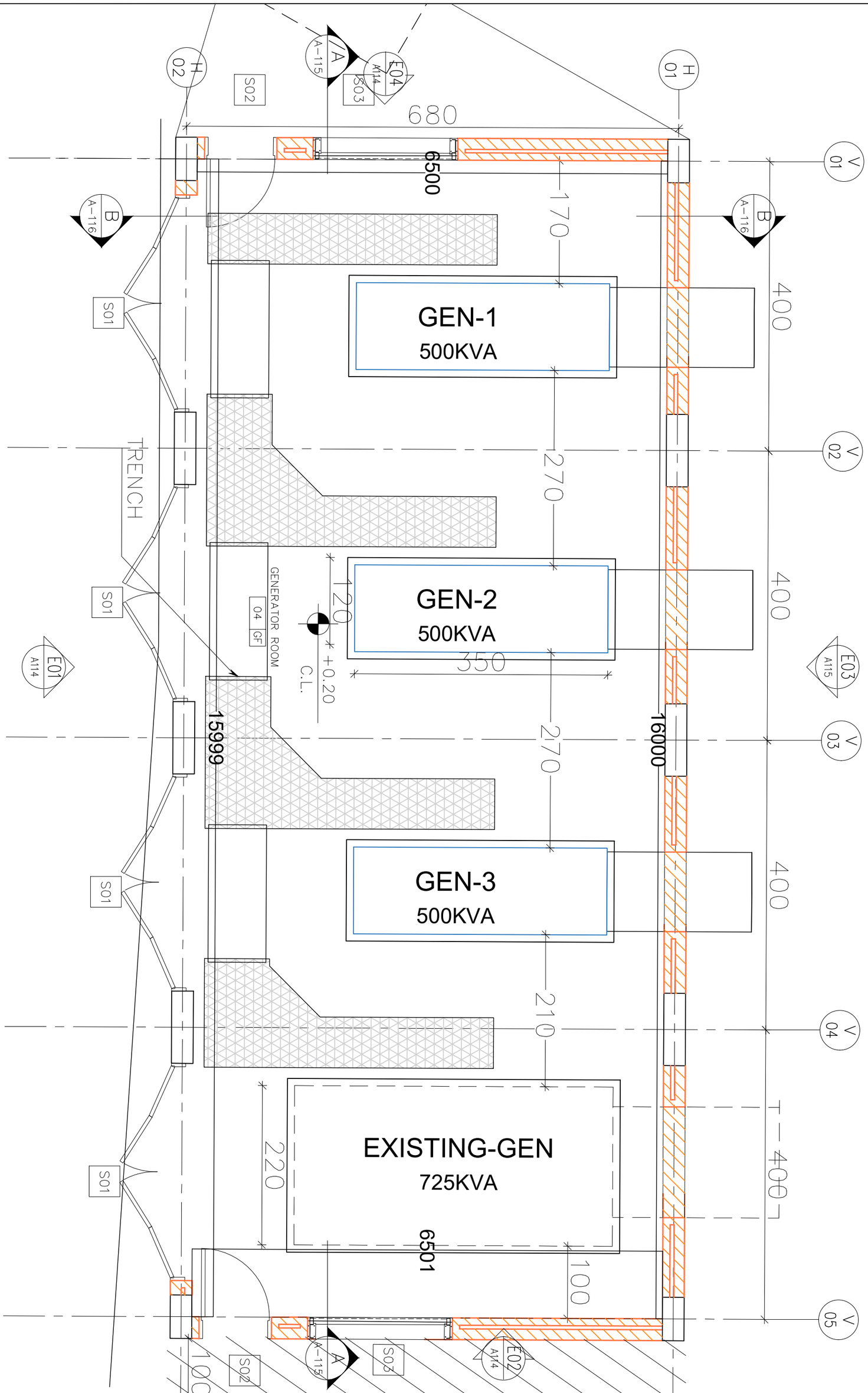
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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
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		DATE:	SEP. 2026
		DRAWN:	N.D.
		CHECKED:	A.M.
		APPD:	A.M.
		SHEET SIZE: A1	1/1
	L2026-14	PROJ. No.:	
	A-114	DWG. No.:	

PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW GENERATOR ROOM-PLAN

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

V 01
V 02
E03 A115
V 03
V 04
V 05
400
400
400
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B A-116
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680
E04 A114
/A A-115
** **
NEW BUILT-UP ROOFING WITH PROPER SLOPE
E02 A114
S03
A A-115
S02
100
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E01 A114

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3 – XXXXX	Rev3	X.X	X/XX/XX
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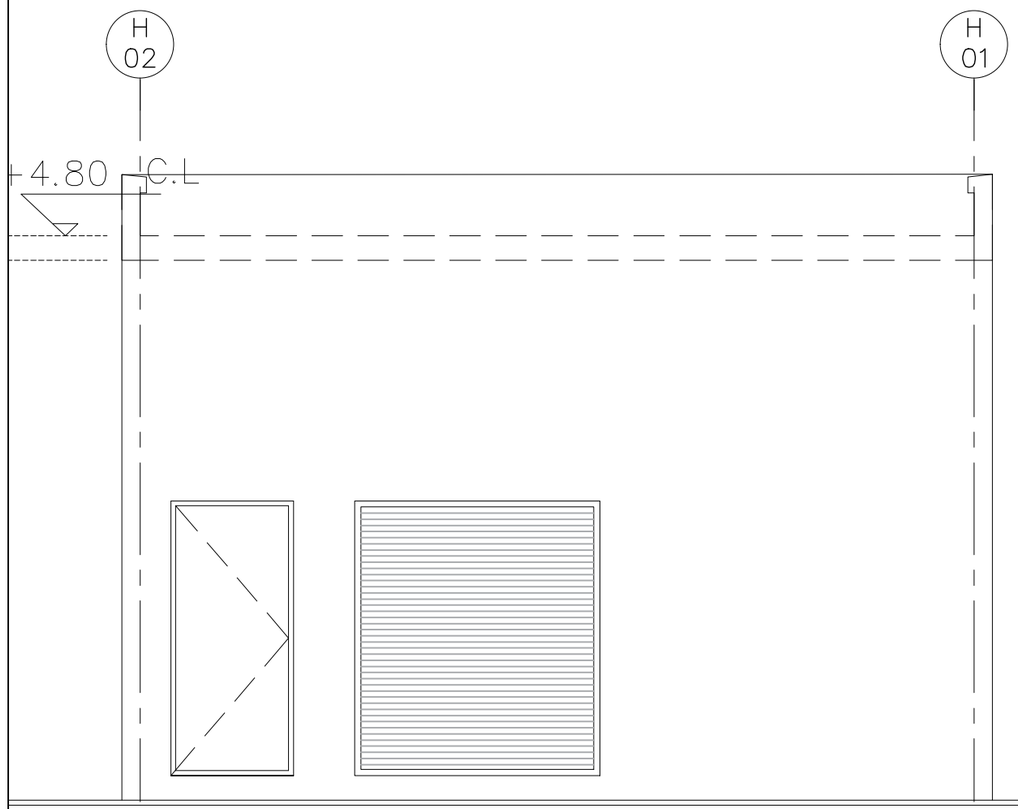
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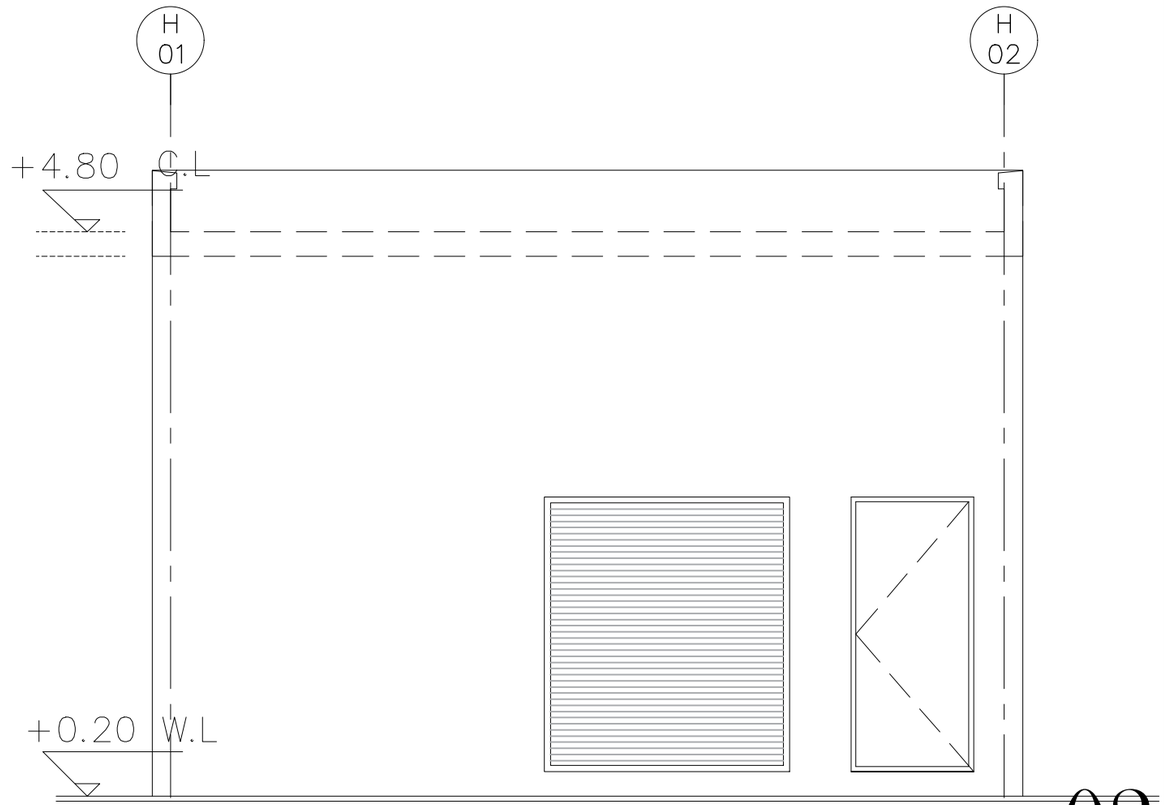
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GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW GENERATOR ROOM- ROOF PLAN

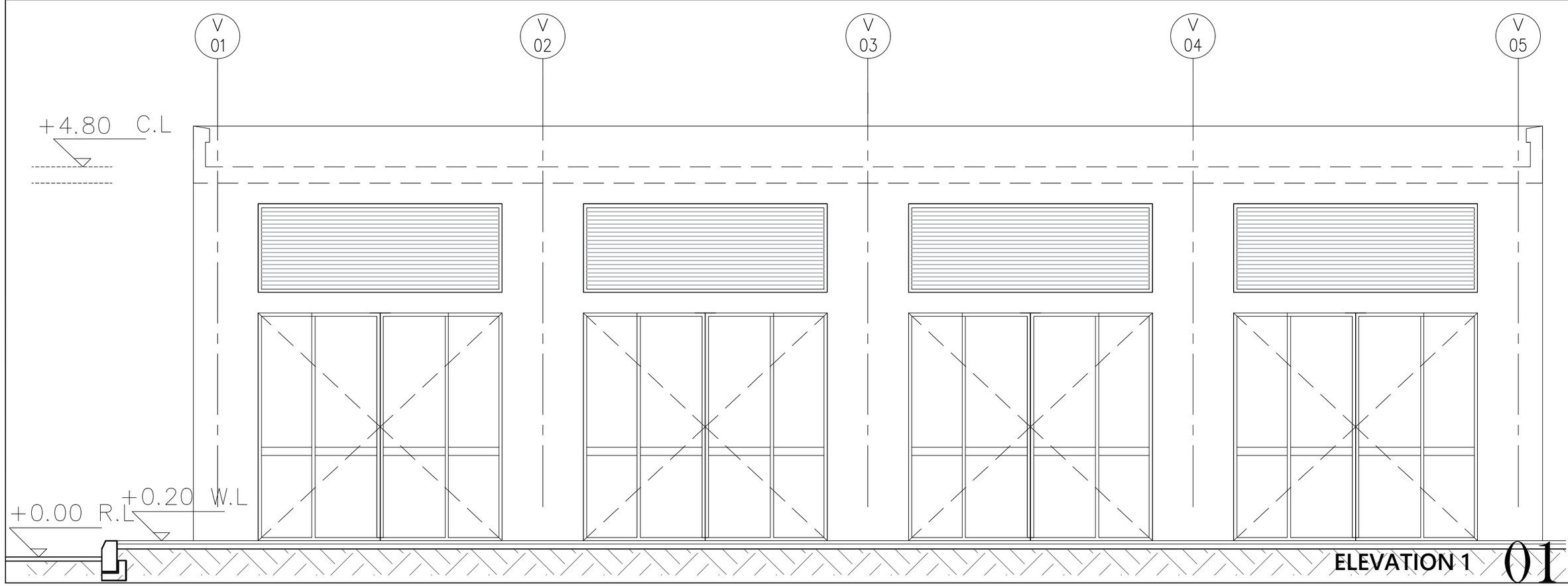
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PROJ. No.:	DWG. No.:
L2026-14	A-115
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-A115



ELEVATION 4 03



ELEVATION 2 02



ELEVATION 1 01

NOTES
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6 – XXXXX	Rev6	X.X	X/XX/XX

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GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW GENERATOR ROOM– ELEVATION

SCALE:	1/25
DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
SHEET SIZE A:	0 1 2 3 4
PROJ. No.:	DWG. No.:
L2026-14	A–116

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A116

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2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
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5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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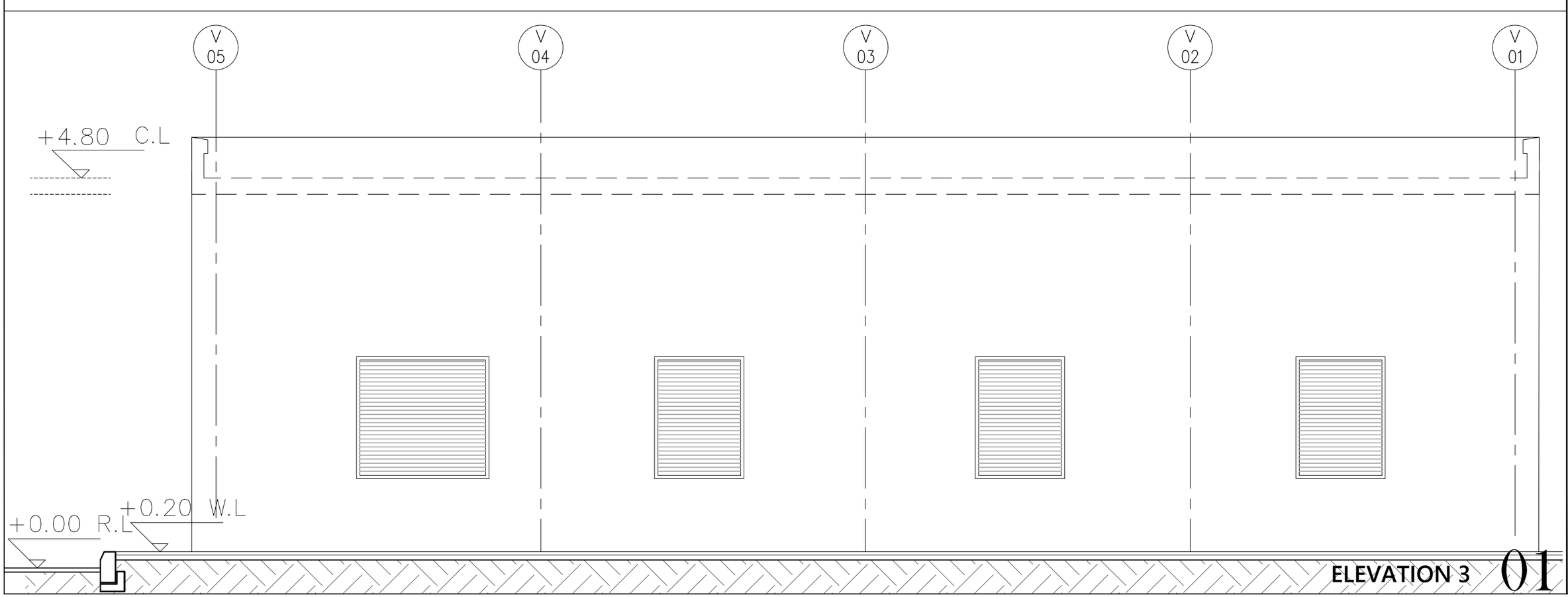
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GENERAL DIRECTORATE BAABDA, LEBANON

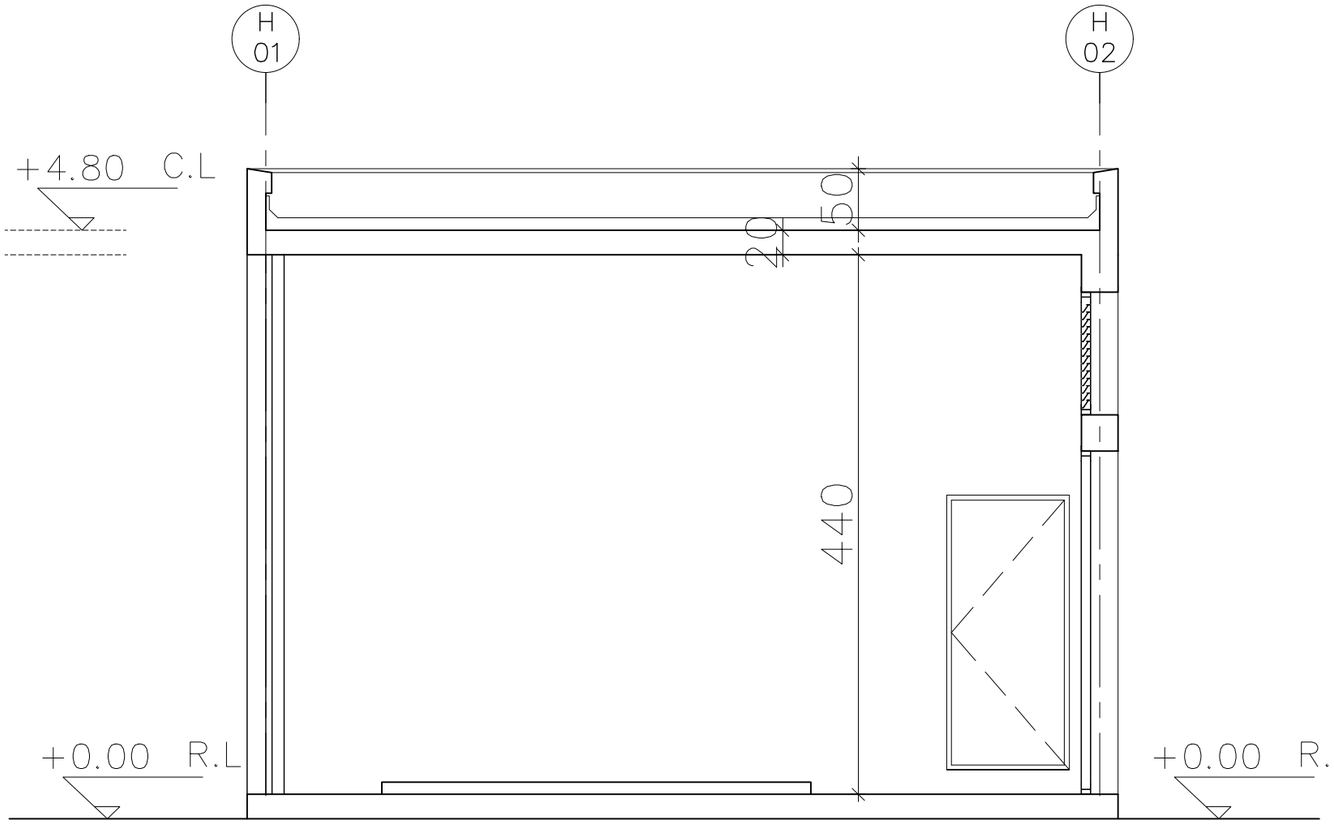
MAIN ELECTRICAL / GENERATOR ROOMS

NEW GENERATOR ROOM– ELEVATION SECTION

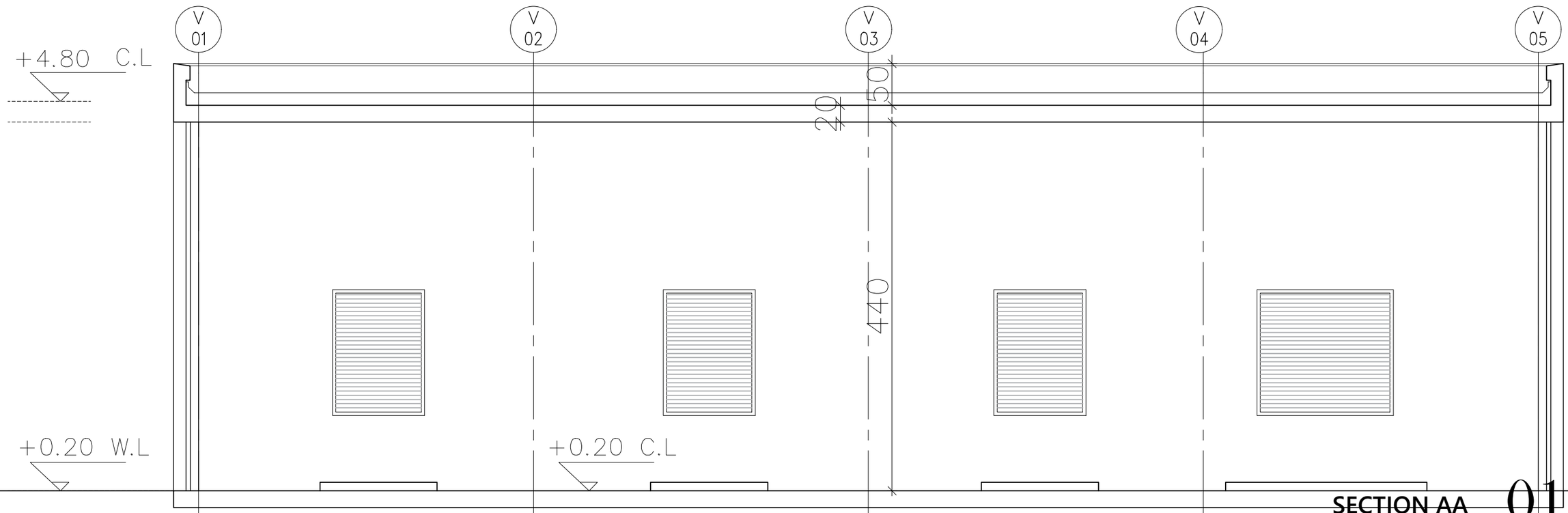
SCALE:	1/25
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CHECKED:	A.M.
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SHEET SIZE A:	A0 A1 A2 A3 A4
PROJ. No.:	DWG. No.:
L2026-14	A–117
APP'D FOR CONSTRUCTION :	
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ELEVATION 3 01



SECTION BB 02



SECTION AA 01

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4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND

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PRESIDENTIAL PALACE

GENERAL DIRECTORATE BAABDA, LEBANON

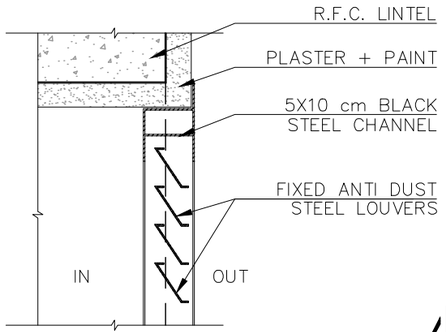
MAIN ELECTRICAL / GENERATOR ROOMS

NEW GENERATOR ROOM- SECTION

SCALE:	1/25
DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
SHEET SIZE A:	A1
PROJ. No.:	DWG. No.:
L2026-14	A-118

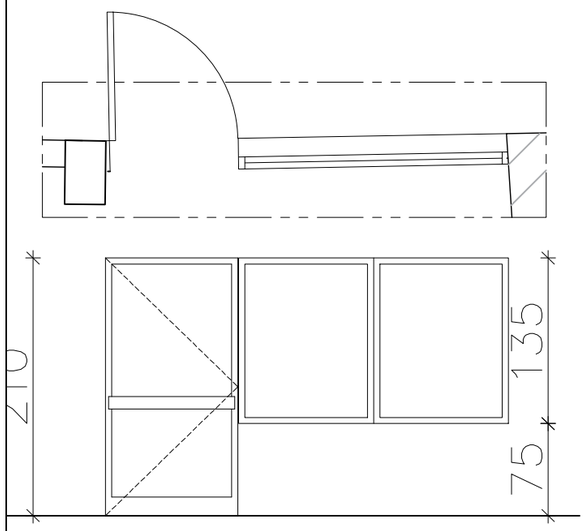
APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A118



TYPICAL SECTION FOR FIXED
ANTI-DUST STEEL LOUVERS

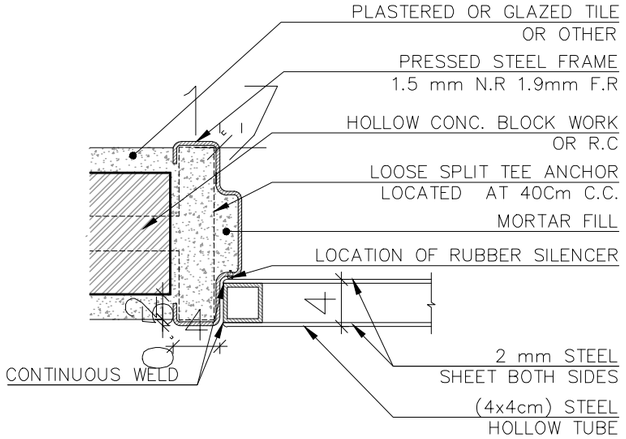
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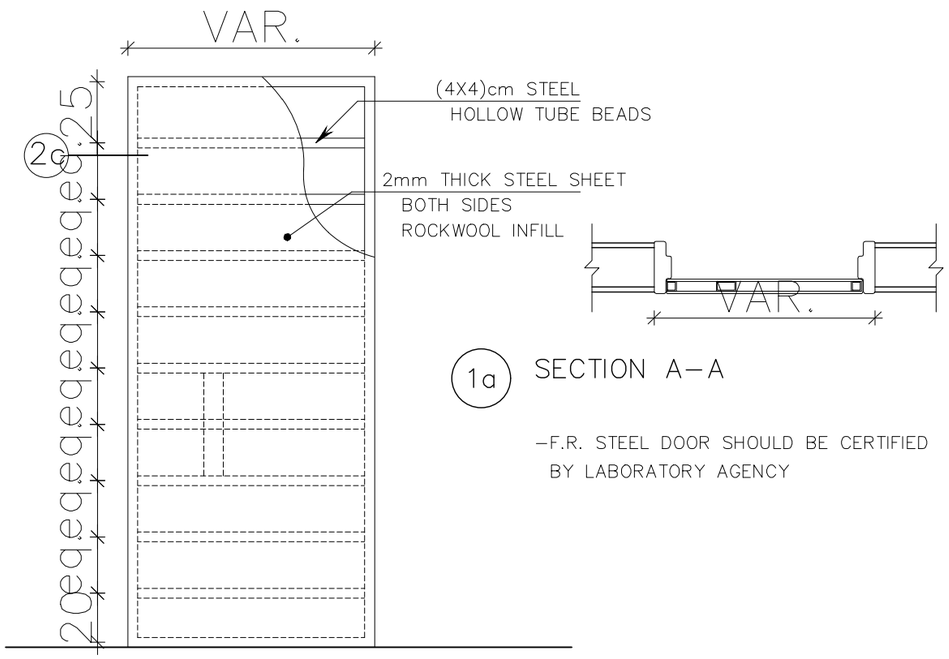
ELEVATION

– SIDE HINGED GLAZED ALUMINUM WINDOW WITH FLUSH ALUM BOTTOM

W01



2c DETAIL 1



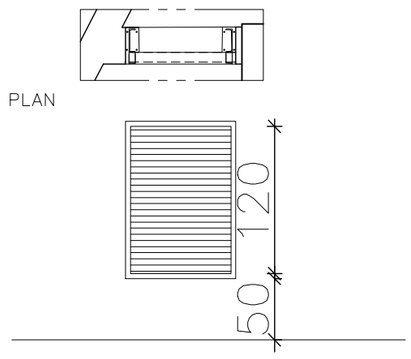
1a SECTION A–A

2b ELEVATION OF STEEL DOOR

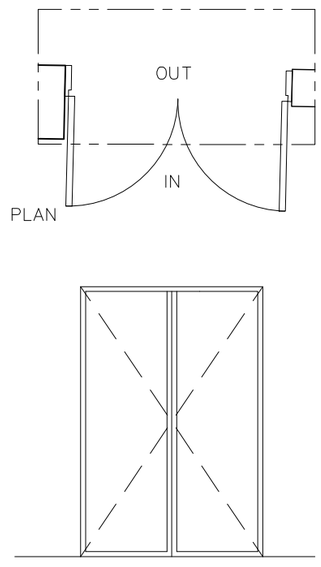
–F.R. STEEL DOOR SHOULD BE CERTIFIED
BY LABORATORY AGENCY

STEEL DOOR DETAILS

5

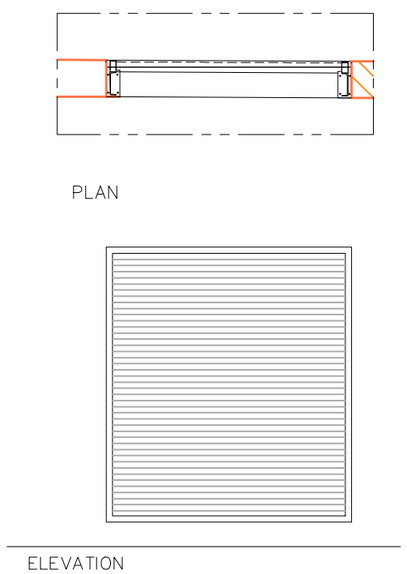


S05



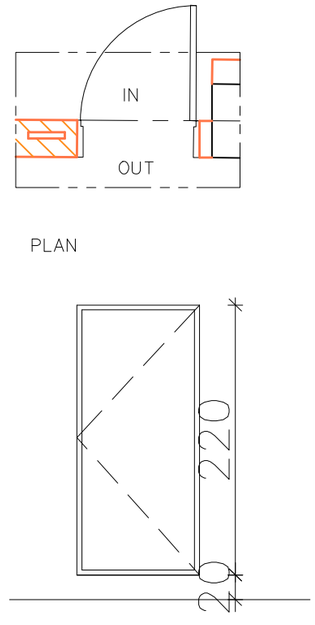
–DOUBLE LEAF SIDE HINGED STEEL

S04



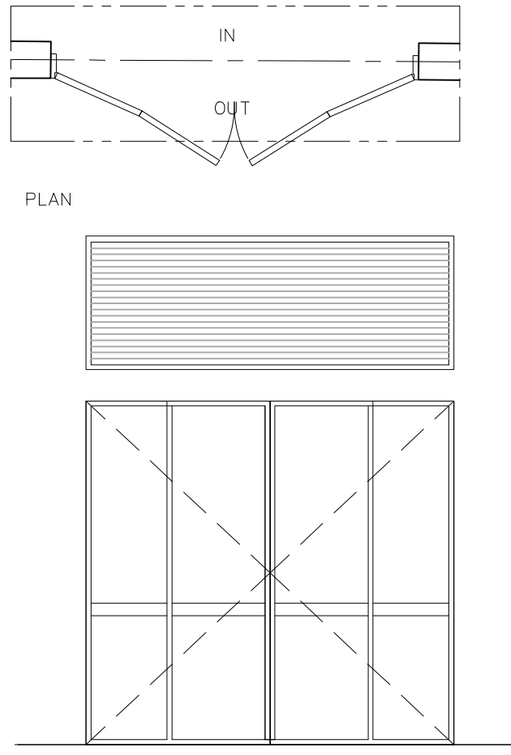
– STEEL BURGLAR PROOF PANELS WINDOW
WITH PRESSED STEEL FRAME

S03



–SINGLE LEAF SIDE HINGED STEEL

S02



–DOUBLE LEAF SIDE HINGED STEEL WITH UPPER LOVER

S01

1

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1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND
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3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

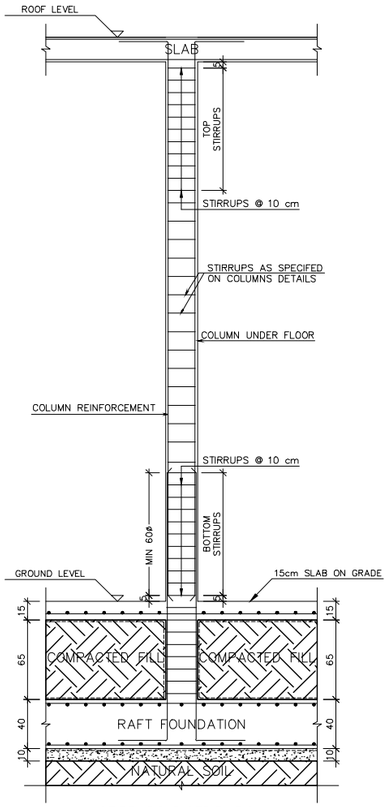
NOTES
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2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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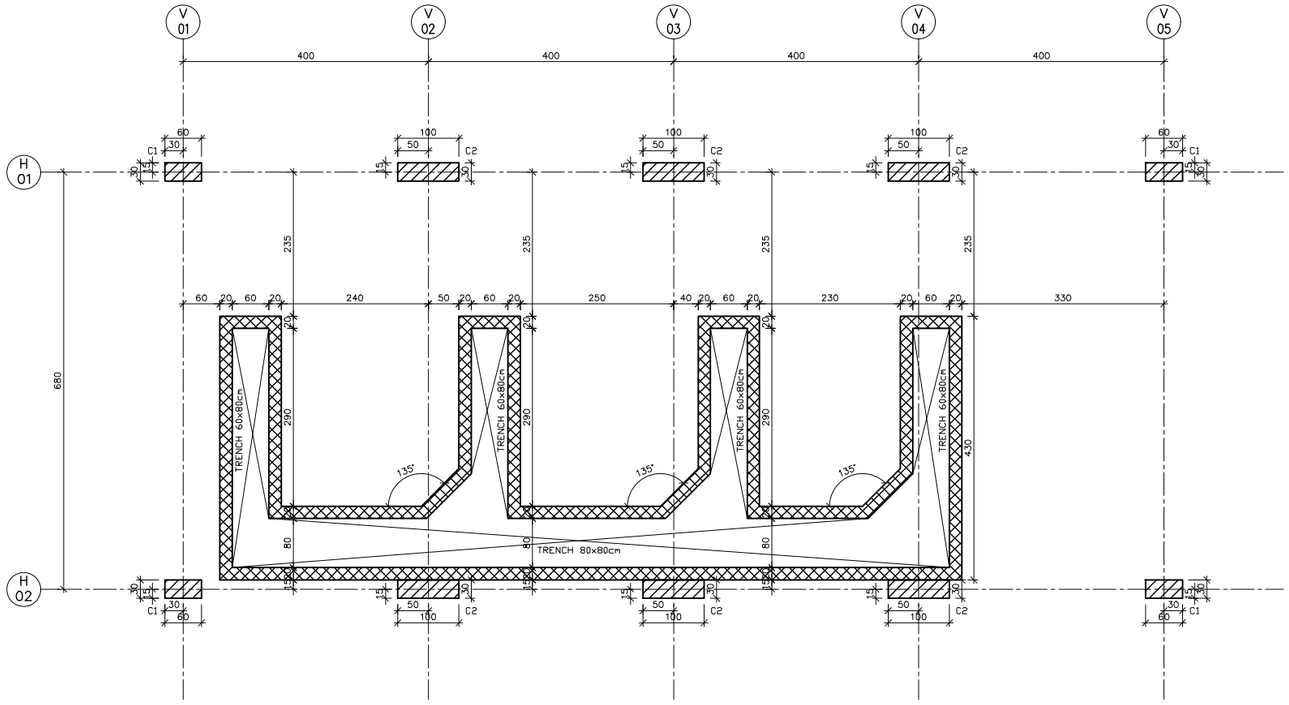
PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM – STEEL SCHEDULE

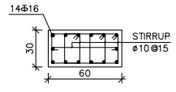
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DATE:	SEP. 2026
DRAWN:	N.D
CHECKED:	A.M.
APP'D:	A.M.
SHEET SIZE A:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2024-02	A–119
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COMPUTER CODE No.	L2026-14-A119

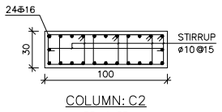
STRUCTURAL DRAWINGS



STIRRUPS DISTRIBUTION
COLUMN CONNECTION AT RAFT FOUNDATION





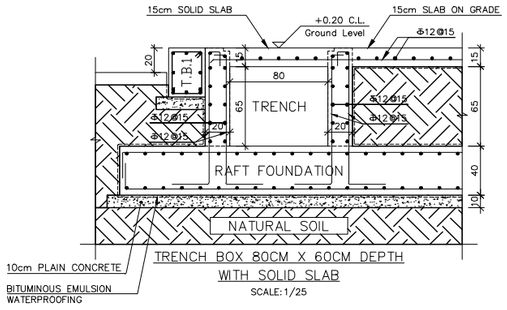


UNDER SLAB ON GRADE FRAMING PLAN 2
SCALE 1/50

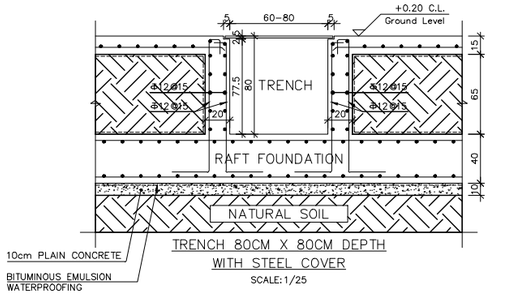
NOTES :
1- THE DESIGN BASED IN ACCORDANCE TO ACI 318-14 CODE.

2- THE CONCRETE COMPRESSIVE STRENGTH OF THE CONCRETE ELEMENT IS Fc= 30 Mpa.

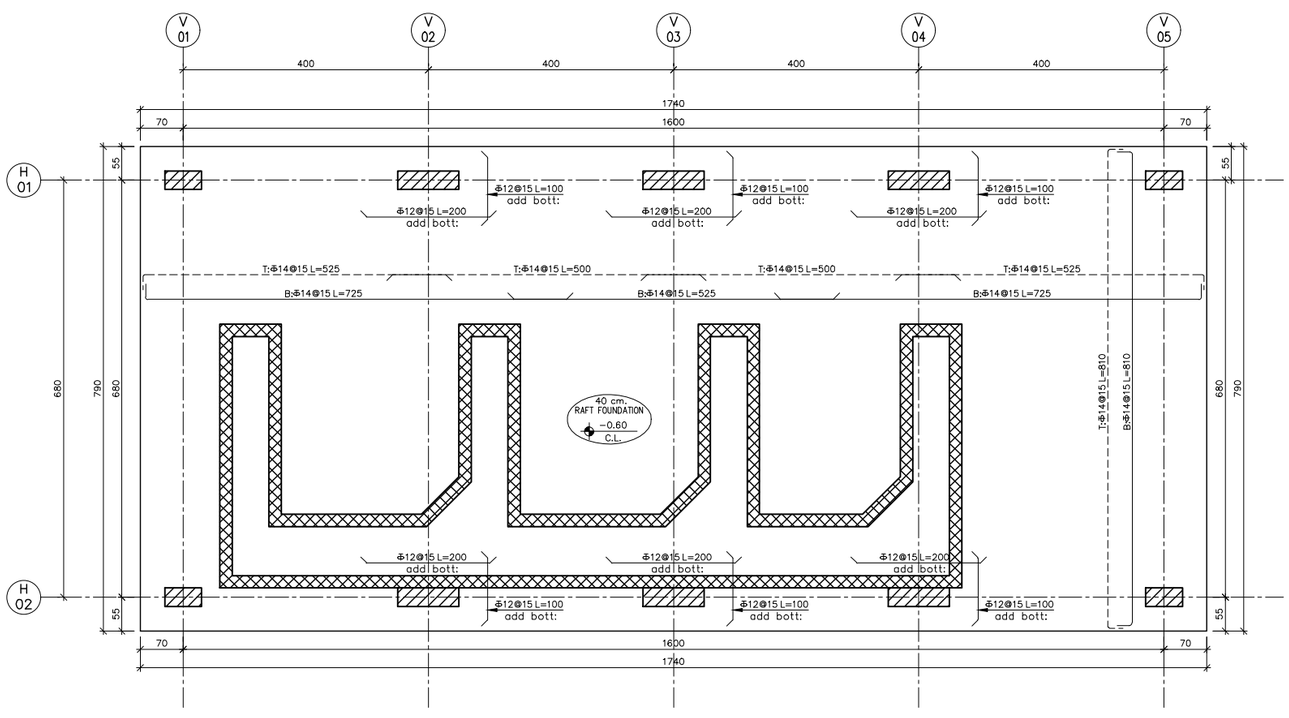
3- THE YIELD STRENGTH OF THE REINFORCEMENT STEEL BARS IS 420 Mpa.



TRENCH BOX 80CM X 60CM DEPTH
WITH SOLID SLAB
SCALE: 1/25



TRENCH 80CM X 80CM DEPTH
WITH STEEL COVER
SCALE: 1/25



FOUNDATION PLAN 1
SCALE 1/50

NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

LEGEND
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2 ———————
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4 ———————
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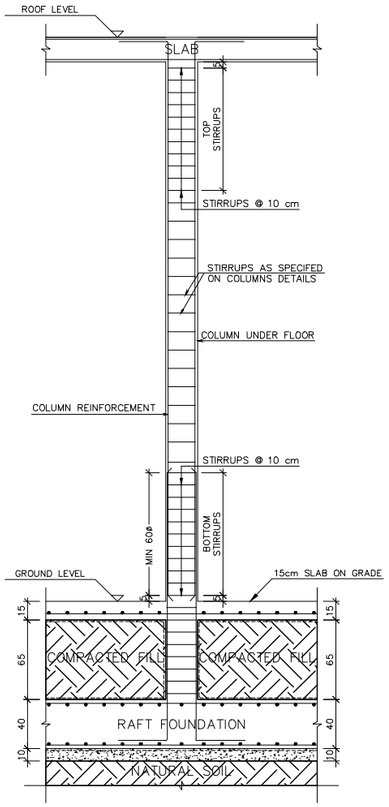
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6 – XXXXX	Rev6	X.X	X/XX/XX

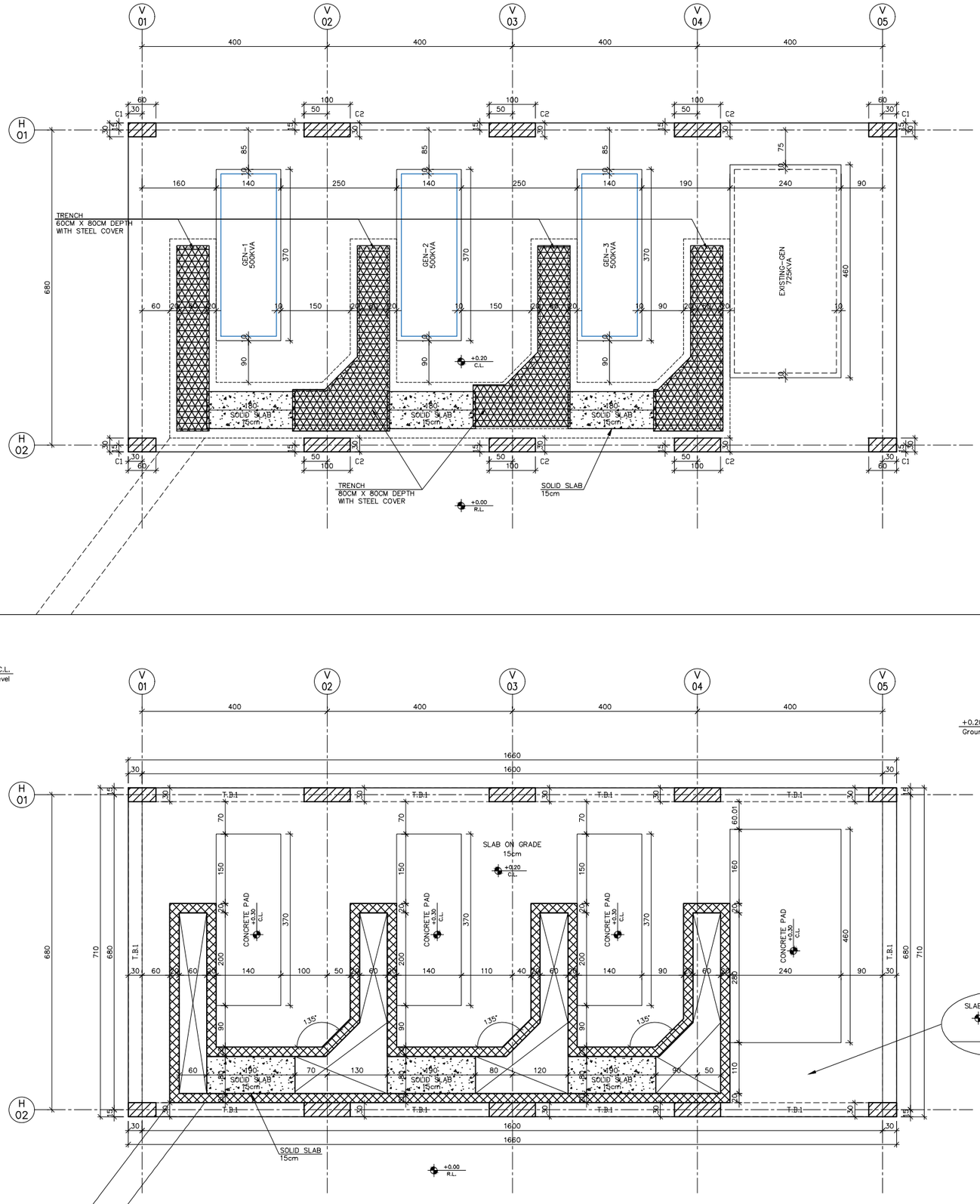
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GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW GENERATOR ROOM-PLANS & DETAILS 1/3

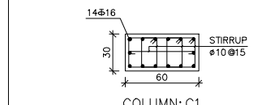
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DATE:	SEP-2026
DRAWN:	M.SH.
CHECKED:	E.A.E.
APP'D:	A.M.
SHEET SIZE A:	A0 A1 A2 A3 A4
PROJ. No.:	DWG. No.:
L2026-14	S-201
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-S201



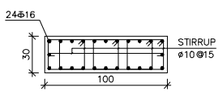
STIRRUPS DISTRIBUTION
COLUMN CONNECTION AT RAFT FOUNDATION



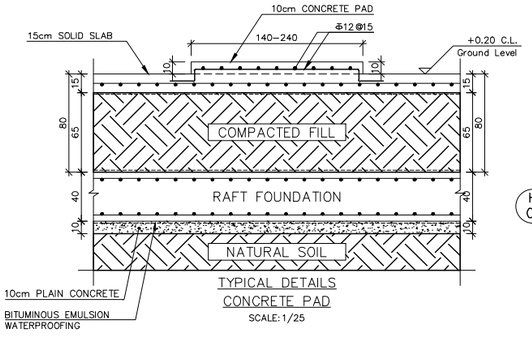
GROUND FLOOR FRAMING PLAN
SCALE 1/50 **4**



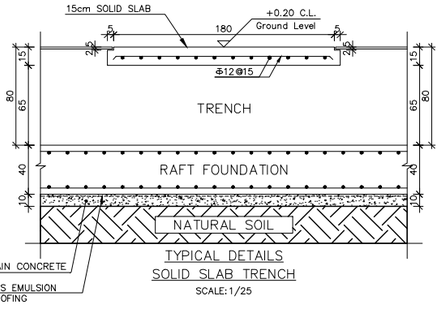
COLUMN: C1
SC: 1/25



COLUMN: C2
SC: 1/25

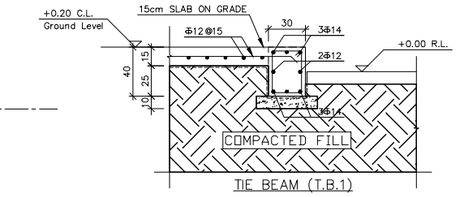


TYPICAL DETAILS
CONCRETE PAD
SCALE:1/25

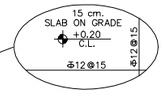


TYPICAL DETAILS
SOLID SLAB TRENCH
SCALE:1/25

GROUND FLOOR REINFORCEMENT SLAB ON GRADE PLAN
SCALE 1/50 **3**



TIE BEAM (T.B.1)
SECTION & DETAILS
SCALE:1/25



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3 – XXXXX	Rev3	X.X	X/XX/XX
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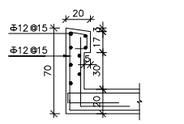
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NOTES
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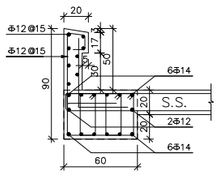
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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW GENERATOR ROOM-PLANS & DETAILS 2/3

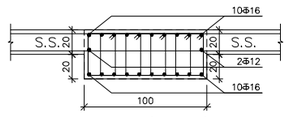
SCALE:	1/50 – 1/25
DATE:	SEP–2026
DRAWN:	M.SH.
CHECKED:	E.A.E.
APP'D:	A.M.
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DWG. No.:	S–202
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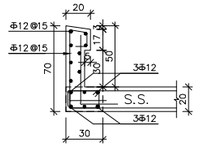
TYPICAL DETAIL ROOF
SC: 1/25



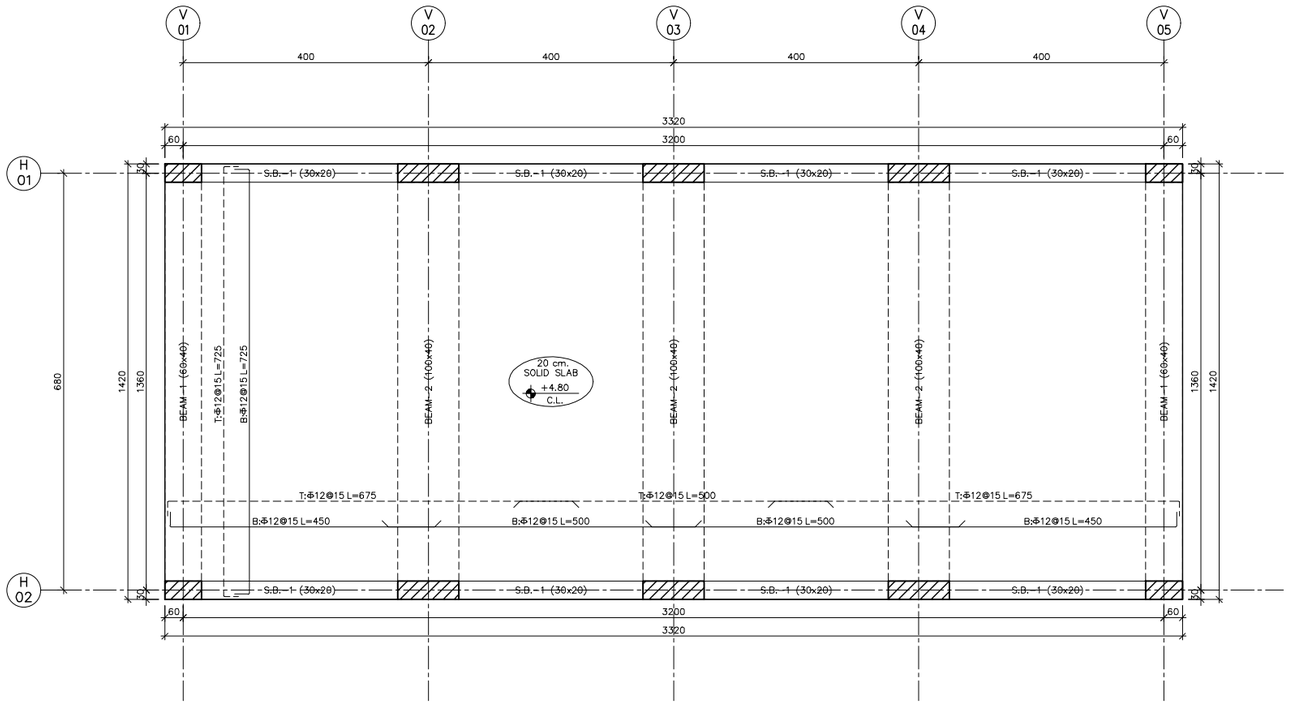
BEAM–1 (60x40)
SC: 1/25

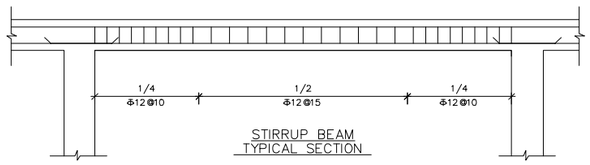


BEAM–2 (100x40)
SC: 1/25



SECONDARY BEAM
S.B.–1 (30x20)
SC: 1/25





STIRRUP BEAM
TYPICAL SECTION

ROOF REINFORCEMENT SLAB PLAN 5
SCALE 1/50

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3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
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2 –
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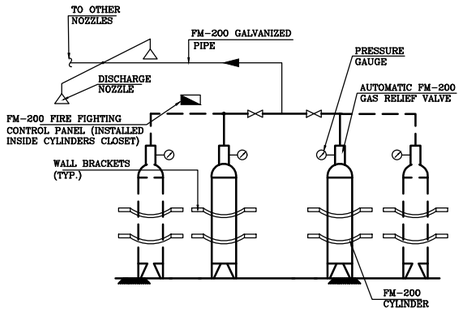
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1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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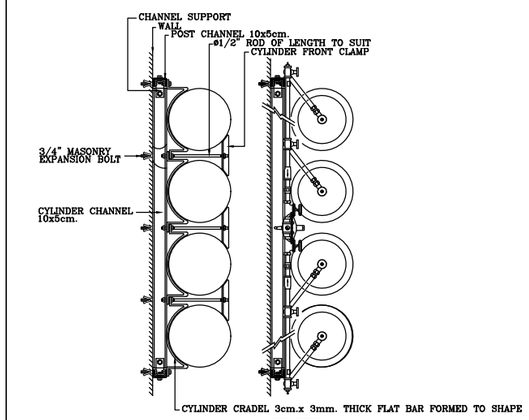
PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW GENERATOR ROOM–PLANS & DETAILS 3/3

SCALE:	1/50 – 1/25
DATE:	SEP–2026
DRAWN:	M.SH.
CHECKED:	E.A.E.
APP'D:	A.M.
SHEET SIZE A:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026–14	S–203
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-S203

MECHANICAL DRAWINGS

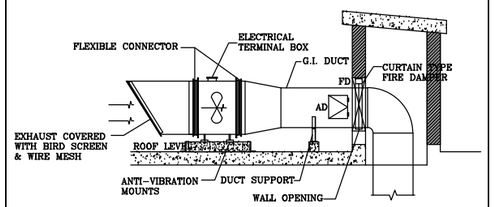


FM-200 CYLINDERS MOUNTING DETAILS

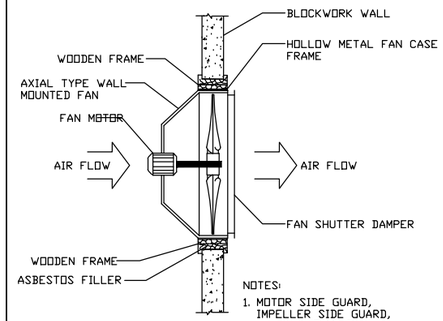


NUMBER OF CYLINDERS TO BE AS SHOWN ON THE DRAWINGS

DETAIL OF CYLINDER SUPPORT



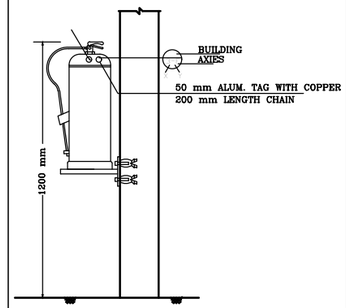
EXHAUST FAN DETAILS



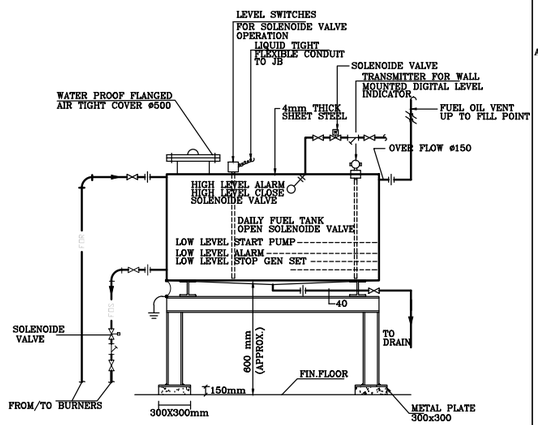
NOTES:
1. MOTOR SIDE GUARD, IMPELLER SIDE GUARD, FAN MOUNTING PLATE,
2. LOUVER SHUTTER, SPEED CONTROLLER.

HIGH EFFICIENCY AXIAL FAN AND WEATHERPROOF PROTECTED.

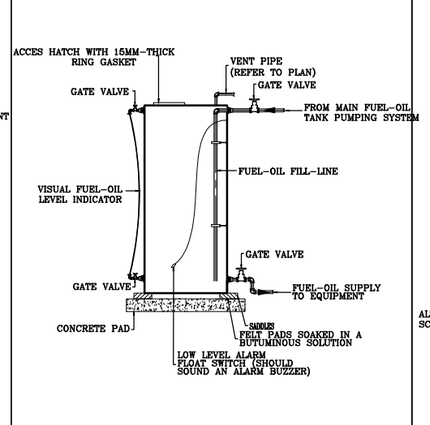
EXHAUST FAN-WALL MOUNTED TYPE



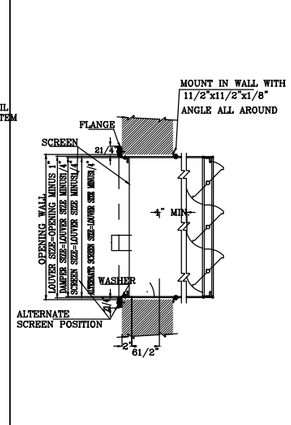
WALL HUNG FIRE EXTINGUISHER



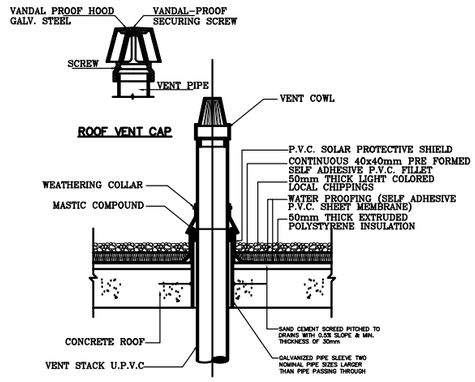
FUEL OIL TANK DETAIL



FUEL OIL TANK HOOK UP DETAIL

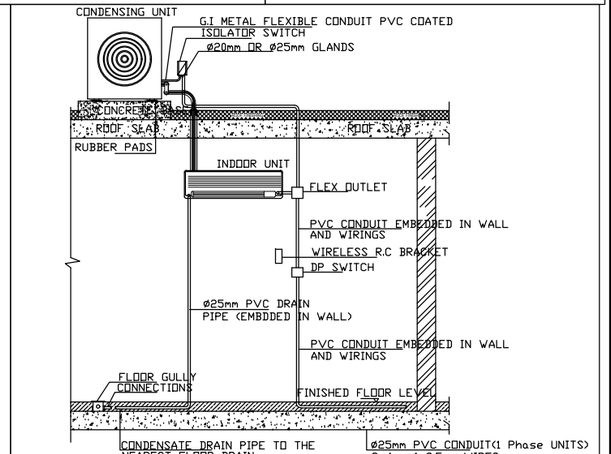


OUTDOOR AIR LOUVER AND SCREEN DETAIL

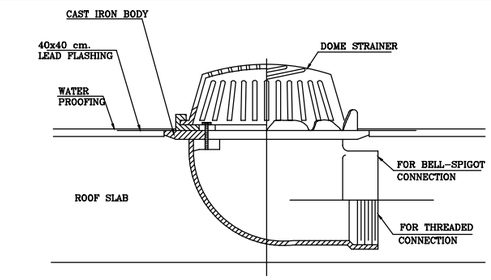


NOTES:
1-FOR WATER PROOFING DETAIL REFER TO ARCHITECTURAL DRAWINGS.
2-FOR ROOF FINISH DETAIL REFER TO ARCHITECTURAL DRAWINGS.

VENT STACK DETAIL

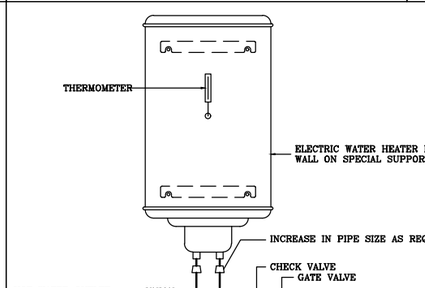


A/C INDOOR & OUTDOOR UNIT INSTALLATION DETAILS WALL MOUNTED TYPE

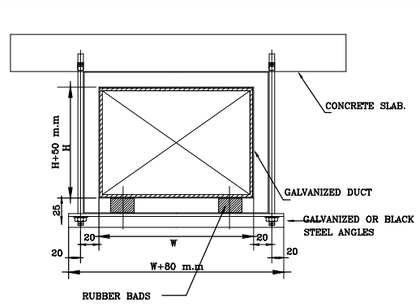


NOTES:-
1-FOR WATER PROOFING DETAIL REFER TO ARCHITECTURAL DRAWINGS.
2-FOR ROOF FINISH DETAIL REFER TO ARCHITECTURAL DRAWINGS.

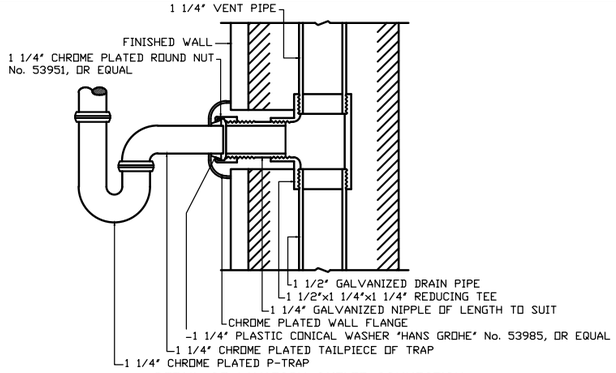
ROOF DRAIN SIDE OUTLET DETAIL



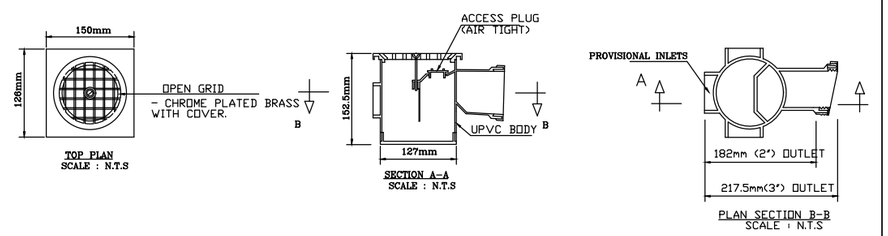
ELECTRIC WATER HEATER HOOK UP DETAIL



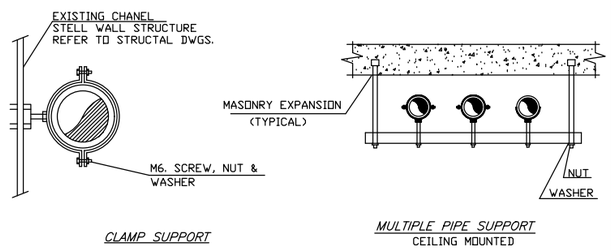
INSULATED DUCT SUPPORTING SYSTEM DETAIL



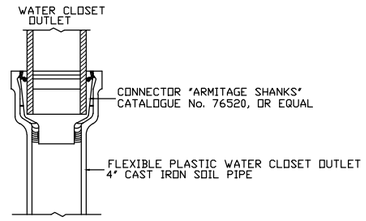
DETAIL OF LAVATORY OUTLET CONNECTION



PVC FLOOR DRAIN DETAIL



PIPES SUPPORT AND HANGERS



DETAIL OF WATER CLOSET OUTLET CONNECTION

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND	NOTES
1 – ----------	1 – XXXXX
2 – ----------	2 – XXXXX
3 – ----------	3 – XXXXX
4 – ----------	4 – XXXXX
5 – ----------	5 – XXXXX
6 – ----------	6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
GENERAL MECHANICAL DETAILS

SCALE:	1/50
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	A2
PROJ. No.:	L2026-14
DWG. No.:	M-301
APP'D FOR CONSTRUCTION :	

COMPUTER CODE No.| L2026-14-M301

* CALCULATION NOTES RELATED TO FM200 FIRE SUPPRESSION FOR TRANSFORMER ROOM GF-03:

-ROOM VOLUME IS 75m2 (AREA) * 3m (HEIGHT) =225m3
-FM-200 CONCENTRATION WILL BE 7-9% FOR FIRE SUPPRESSION
-FM-200 GAS DENSITY IS AROUND 0.55KG/m3,THEN THE AMOUNT OF GAS NEEDED WILL BE 225m3 ROOM VOLUME x0.55KG/m3 DENSITY =123.75KG
-THE SELECTED CYLINDERS WILL BE 3*45KG
-AS RECOMMENDED FOR HEIGHT 3m, MAXIMUM COVERAGE AREA WILL BE PER NOZZLE WILL BE 60m2 (AROUND 8.7m DIAMETER)
-MINIMUM NUMBER OF NOZZLES WILL BE 75m2:60m2/NOZZLE =1.25 NOZZLE (SELECTED TWO NOZZLES)

* CALCULATION NOTES RELATED TO FM200 FIRE SUPPRESSION FOR GENERATOR ROOM GF-04:

-ROOM VOLUME IS AROUND 105m2 (AREA) * 5.2m (HEIGHT) =546m3
-FM-200 CONCENTRATION WILL BE 7-9% FOR FIRE SUPPRESSION
-FM-200 GAS DENSITY IS AROUND 0.55KG/m3,THEN THE AMOUNT OF GAS NEEDED WILL BE 546m3 ROOM VOLUME x0.55KG/m3 DENSITY =300.3KG
-THE SELECTED CYLINDERS WILL BE 7*45KG
-AS RECOMMENDED FOR HEIGHT 5.2m, MAXIMUM COVERAGE AREA WILL BE PER NOZZLE WILL BE 45m2 (AROUND 7.5m DIAMETER)
-MINIMUM NUMBER OF NOZZLES WILL BE 105m2:45m2/NOZZLE =2.33 NOZZLES (SELECTED FOUR NOZZLES)

* CALCULATION NOTES RELATED TO VENTILATION SYSTEM FOR TRANSFORMER ROOM GF-03:

-TRANSFORMER CAPACITY IS 1000 KVA + 1600 KVA
-ESTIMATED HEAT DISSIPATION FROM T-1000KVA + T-1600KVA IS 35kW (AROUND 8.5TR)
-ESTIMATED REQUIRED VENTILATION AIR FLOW IS 8.5TR x400CFM/TR =3400 CFM
-ESTIMATED LOUVER'S AREA (m2) = $\frac{\text{AIR FLOW (CFM)}}{\text{VELOCITY(FPM) x10.76FT2/M2 x FREE AREA RATIO}}$

* CALCULATION NOTES RELATED TO VENTILATION SYSTEM FOR GENERATOR ROOM GF-04:

-FOR GENERATOR 500 KVA,THE RECOMMENDED COOLING RADIATOR AIR FLOW IS AROUND 20000 CFM
-FOR GENERATOR 725 KVA,THE RECOMMENDED COOLING RADIATOR AIR FLOW IS AROUND 40000 CFM
-ESTIMATED LOUVER'S AREA (m2) = $\frac{\text{AIR FLOW (CFM)}}{\text{VELOCITY(FPM) x10.76FT2/M2 x FREE AREA RATIO}}$

* CALCULATION NOTES RELATED TO FANS STATIC PRESSURE:

-STATIC PRESSURE CALCULATION IS DONE CONSIDERING THE FOLLOWING:
*60Pa PRESSURE DROP AT AIR LOUVERS
*10Pa PRESSURE DROP AT EXHAUST REGISTERS
*0.65Pa/m DUCTS FRICTION LOSS FOR APPROXIMATE 15m LENGTH
*100% SAFETY FACTOR FOR DUCTS FITTINGS AND SAFETY

-THE REQUIRED STATIC PRESSURE CALCULATION FOR EXF-3400
=3m x0.65Pa/m x2 (100% SAFETY FACTOR) +0Pa (REGISTER) +60Pa (LOUVER) =63.9Pa

* FUEL OIL TANKS VOLUME CALCULATION NOTE:

-ESTIMATED FUEL OIL CONSUMPTION FOR GENERATOR 500KVA IS AROUND 100L/h/GEN.
-REQUIRED FUEL STORAGE FOR 2 DAYS WITH 24h/DAY EMERGENCY RUNNING WILL BE: 100L/h/GEN. x2GEN. x24h/DAY x2DAYS =9600L (AROUND 10m3)
-SELECTED FUEL TANK WILL BE 2.4m x1.2m x2.4m (AROUND 7m3) DUE TO THE CONNECTION TO THE EXISTING 40m3 STORAGE FUEL TANK ALREADY AVAILABLE

* ELECTRIC WATER HEATER (EWH) CALCULATION NOTE

-ELECTRIC WATER HEATER (EWH) CAPACITY IS DONE AS PER INTERNATIONAL PLUMBING CODE:

*23 L/h/LAVATORY
*114 L/h/SHOWER
*0.3 DEMAND FACTOR
*2 HOURS STORAGE CAPACITY

THEREFORE THE MAXIMUM REQUIRED HOT WATER HEATER CAPACITY WILL BE CALCULATED AS FOLLOW:
- 1 LAV: 23L/h/LAV x1LAV x0.3 x2h =13.8L (SAY 15L)
- 1 SHOWER: 114L/h/SHOWER x1SHOWER x0.3 x2h =68.4L (SAY 70L)

THEREFORE THE MAXIMUM REQUIRED HOT WATER HEATER CAPACITY WILL BE: 85L
SELECTED ELECTRIC WATER HEATER TANK WILL BE 100L (EWH-100)

HVAC ABBREVIATIONS	
EXF	EXTRACT FAN
GF	GROUND FLOOR
TR	TON REFRIGERATION
CFM	CUBIC FEET PER MINUTE
IP	INGRESS PROTECTION
FPM	FOOT PER MINUTE
FT2	SQUARE FOOT
KVA	KILOVOLT-AMPERES
Kw	KILOWATT
V	VOLT
Ph	PHASE
Hz	HERTZ
h	Hour
°C	DEGREE CELSIUS
m	METER
m2	SQUARE METER
m3	CUBIC METER
Pa	PASCAL
Kg	KILOGRAM
m/s	METER PER SECOND
ø	PIPE DIAMETER
L	LITER
FT2/M2	SQUARE FEET PER MINUTE
GEN	GENERATOR
IU	INDOOR UNIT
OU	OUTDOOR UNIT
DX	DIRECT EXPANSION
dB(A)	A-WEIGHTED DECIBEL
GEN.	GENERATOR
EWH	ELECTRIC WATER HEATER
L/h/LAV	LITER/HOUR/LAVATORY

OUTDOOR AND INDOOR INVERTER DX SPLIT UNITS (HEAT PUMP)	
NAME	IU(DX)/OU(DX)-2.0
QUANTITY	2
TOTAL COOLING CAPACITY	2TR
SENSIBLE COOLING LOAD	1.6TR
AIR FLOW	850 CFM
FAN SPEED	LOW/MEDIUM/HIGH/AUTO
MAXIMUM AIR THROW	12m
ROOM DESIGN TEMPERATURE	23°C
OUTDOOR TEMPERATURE	35°C
REFRIGERANT TYPE	R32 OR R410A
SERVING	CONTROL ROOM
TYPE	CEILING SUSPENDED
INPUT POWER	2.45kW (220V/1Ph/50Hz)
RATED CURRENT	9-11 A
COMPRESSOR TYPE	DC INVERTER ROTARY
INDOOR NOISE LEVEL	36-41 dB(A)
AIR FILTER	WASHABLE SYNTHETIC FILTER
MAXIMUM REFRIGERANT PIPE LENGTH	30m
MAXIMUM ELEVATION DIFFERENCE	10m
CONTROLLER	WIRELESS REMOTE CONTROLLER
DEGREE OF PROTECTION	OU:IP68 / IU:IP54

FANS SCHEDULE		
NAME	EXF-3400	EXF-75
QUANTITY	1	1
AIR FLOW	3400 CFM	75 CFM
STATIC PRESSURE	65 Pa	30 Pa
POWER INPUT	0.37kW(230V/1Ph/60Hz)	0.08kW(230V/1Ph/60Hz)
LOCATION	ROOF	TOILET
SERVING AREAS	TRANSFORMER ROOM GF-04	TOILET
FANS TYPES	CENTRIFUGAL FLOOR MOUNTED FAN	WALL MOUNTED FAN
DEGREE OF PROTECTION	IP68	IP54

ELECTRIC WATER HEATER	
NAME	EWH-100
QUANTITY	1
TYPE	HORIZONTAL MOUNTED
CAPACITY	100L
SET TEMPERATURE	65°C
POWER INPUT	1.5kW (230V/1Ph/50Hz)
DEGREE OF PROTECTION	IP54

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4 - XXXXX	Rev4	X.X	X/XX/XX
5 - XXXXX	Rev5	X.X	X/XX/XX
6 - XXXXX	Rev6	X.X	X/XX/XX

NOTES
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4 - XXXXX
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6 - XXXXX

LEGEND
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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
SCHEDULES OF EQUIPMENT AND CALCULATION NOTES

SCALE:	-/--
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026-14	M-302
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-M302

DRAINAGE AND STORM ABBREVIATIONS	
DN	DOWN
FD	FLOOR DRAIN
HL	HIGH LEVEL
JB	JUNCTION BOX
RVC	ROOF VENT CAP
ST	STORM WATER
SH	SHOWER
VP	VENT PIPE
NO	NUMBER
NOS	NUMBERS
m2	SQUARE METER
UT	UNDER TILES
ø	PIPE DIAMETER

FREE DISCHARGE
ø75,ST,UP
FREE DISCHARGE
ø75,ST,UP
GEN-1 500KVA
GEN-2 500KVA
GEN-3 500KVA
EXISTING-GEN/G4
IN1=2.25
TOP2=4.35
FUEL
GENERATOR ROOM
04 GF
TRANSFORMER ROOM FOR PV PANELS
01 GF
TRANSFORMER ROOM
03 GF
CONTROL ROOM
05 GF
ELECTRICAL ROOM
02 GF
TOILET
06 GF

EWC-01	1 NO
LAV-01	1 NO
SH-01	1 NO

EXISTING SANITARY FIXTURES SHALL BE REMOVED

ø50,VP,UP
ø50,VP
ø50,CDP,UP TO HL
JB-01
ø110,UT
ø110,UT,TO BE CONNECTED TO EXISTING SEWAGE NETWORK
FD-01
ø50,UT
ø50,VP UP TO HL
ø50,CDP TO BE CONNECTED TO THE NEAREST PIPE

NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

LEGEND
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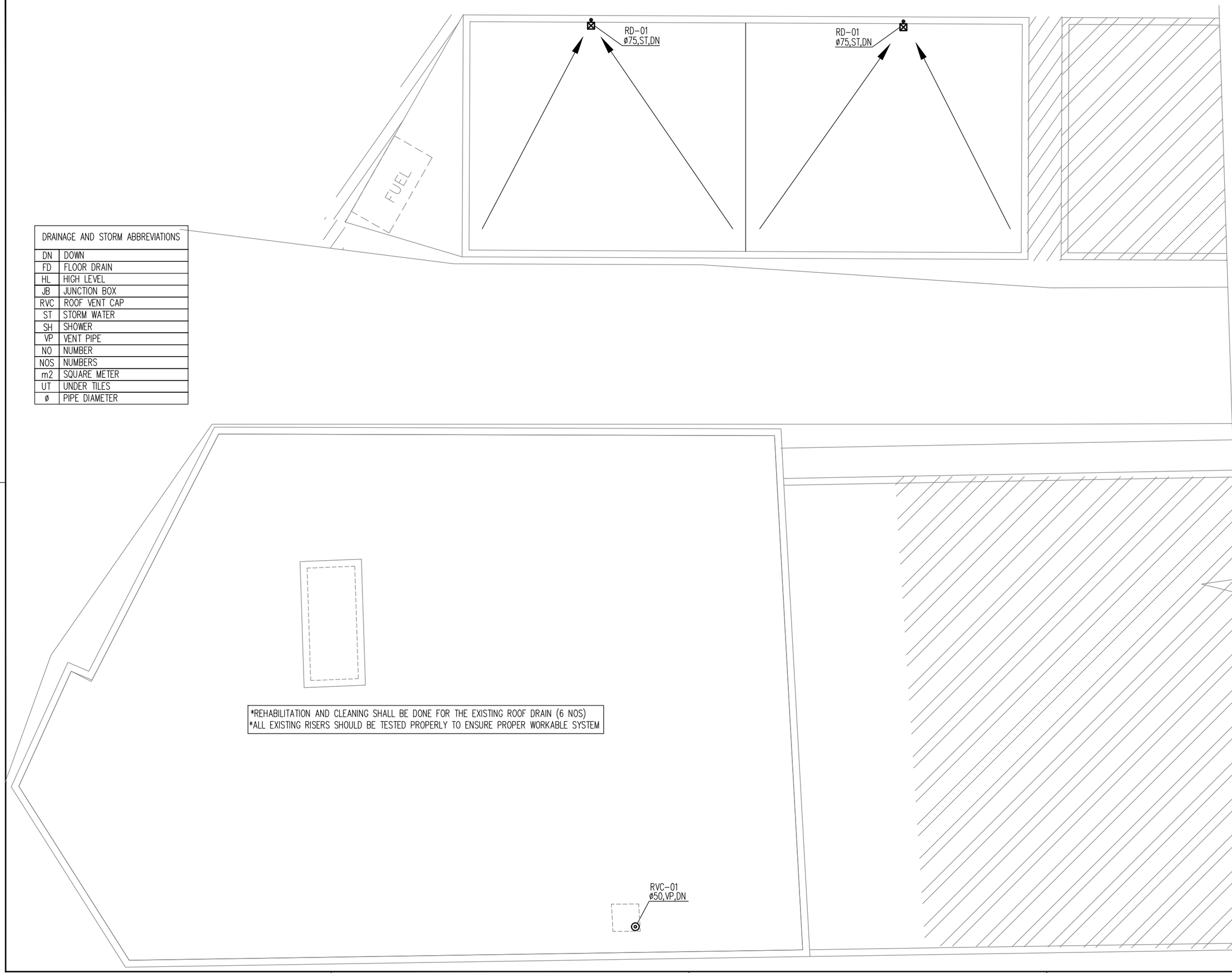
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6 – XXXXX	Rev6	X.X	X/XX/XX

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– YEMEN – SUDAN – ALBANIA –

PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
GROUND FLOOR PLAN-DRAINAGE AND STORM LAYOUT

SCALE:	1/50
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	A1 / 2 / 1 / 0
PROJ. No.:	DWG. No.:
L2026-14	M-303
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.: L2026-14-M303	



DRAINAGE AND STORM ABBREVIATIONS	
DN	DOWN
FD	FLOOR DRAIN
HL	HIGH LEVEL
JB	JUNCTION BOX
RVC	ROOF VENT CAP
ST	STORM WATER
SH	SHOWER
VP	VENT PIPE
NO	NUMBER
NOS	NUMBERS
m2	SQUARE METER
UT	UNDER TILES
ø	PIPE DIAMETER

*REHABILITATION AND CLEANING SHALL BE DONE FOR THE EXISTING ROOF DRAIN (6 NOS)
*ALL EXISTING RISERS SHOULD BE TESTED PROPERLY TO ENSURE PROPER WORKABLE SYSTEM

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LEGEND
1 ----------
2 ----------
3 ----------
4 ----------
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6 ----------

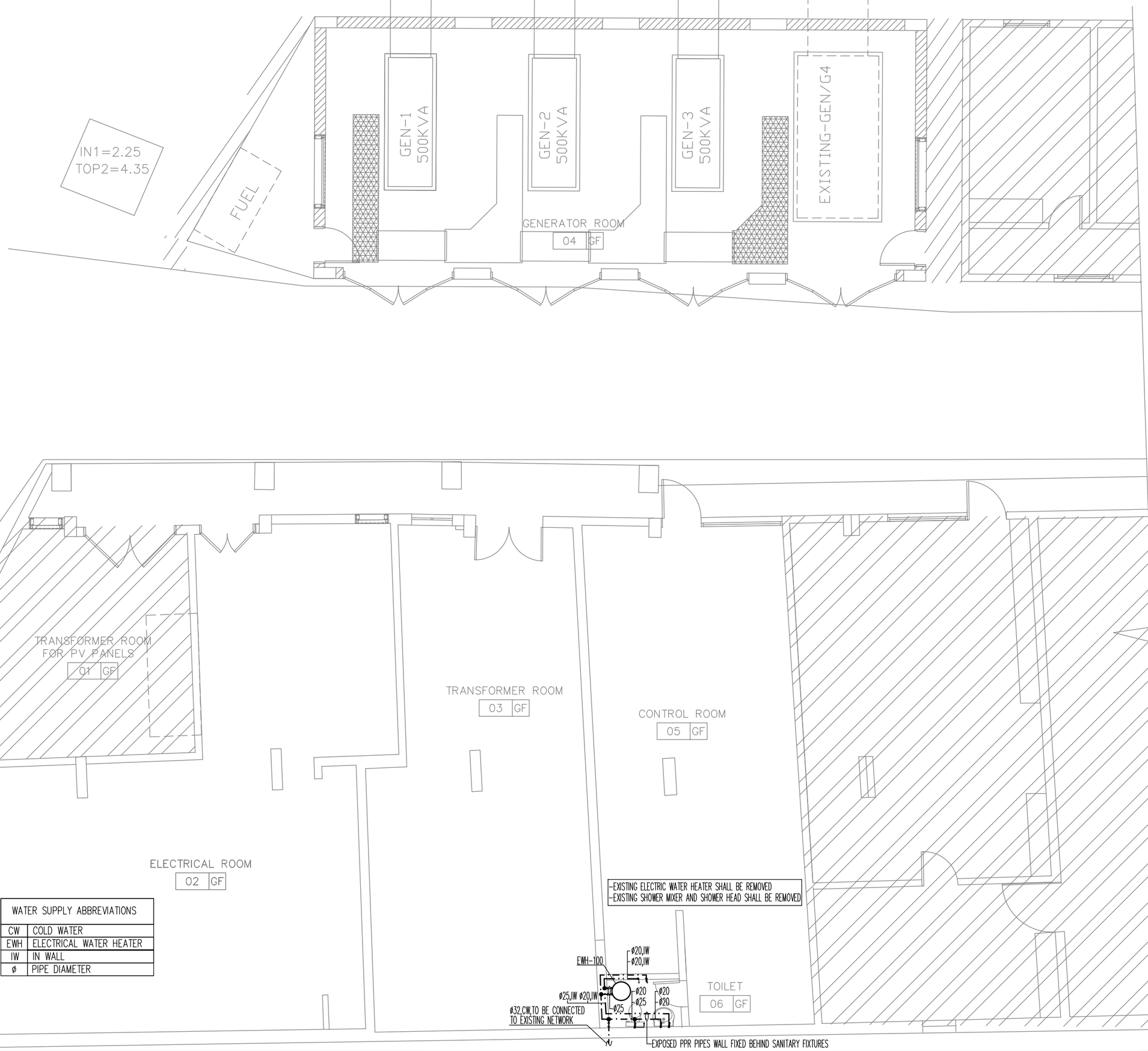
REVISIONS	No.	BY	DATE
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2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
ROOF FLOOR PLAN-DRAINAGE AND STORM LAYOUT

SCALE:	1/50
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	A1
PROJ. No.:	DWG. No.:
L2026-14	M-304
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-M304



WATER SUPPLY ABBREVIATIONS	
CW	COLD WATER
EWH	ELECTRICAL WATER HEATER
IW	IN WALL
ø	PIPE DIAMETER

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4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND

1 – ----------

2 – ----------

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6 – ----------

NOTES

1 – XXXXX

2 – XXXXX

3 – XXXXX

4 – XXXXX

5 – XXXXX

6 – XXXXX

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PRESIDENTIAL PALACE

GENERAL DIRECTORATE BAABDA, LEBANON

MAIN ELECTRICAL / GENERATOR ROOMS

GROUND FLOOR PLAN -WATER SUPPLY LAYOUT

SCALE:	1/50
DATE:	SEP–2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	A1
PROJ. No.:	DWG. No.:
L2026–14	M–305
APP'D FOR CONSTRUCTION :	

COMPUTER CODE No.: L2026-14-M305

FIRE FIGHTING ABBREVIATIONS	
CO2	CARBON DIOXIDE
FM-200	HEPTAFLUOROPROPANE
KG	KILOGRAM
#	NUMBER/NUMBERS
NO	NUMBER
NOS	NUMBERS
m2	SQUARE METER
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
PFE	PORTABLE FIRE EXTINGUISHERS

FM200 Cylinders 7*45kg,Automatic Extinguishers
Fire Suppression System Complete with all Required Accessories

GEN-1 500KVA

GEN-2 500KVA

GEN-3 500KVA

EXISTING-GEN/G4

Seamless Black Steel Pipes
Schedule 40, ASTM A53/A106

FM200 Nozzles 360°
Ceiling-Mounted Nozzles

GENERATOR ROOM
04 GF

IN1=2.25
TOP2=4.35

FUEL

PFE-6L (6LITERS) Foam Type
Portable Fire Extinguisher
Maximum Coverage Area 200m2

PFE-6KG:Dry Chemical Powder
Portable Fire Extinguisher Class ABC
Maximum Coverage Area 200m2

PFE-5KG CO2 Type
Portable Fire Extinguishers
Maximum Coverage Area 200m2

FM200 Cylinders 3*45kg,Automatic Extinguishers
Fire Suppression System Complete with all Required Accessories

Fire Pipes,UP to HL

PFE-6KG:Dry Chemical Powder
Portable Fire Extinguisher Class ABC
Maximum Coverage Area 200m2

Panel Board Interfaced with Heat Detector and Fire Alarm Control Panel
(All Heat Detectors and Indicators will be shown in Fire Alarm Electrical Layout)

TRANSFORMER ROOM
FOR PV PANELS
01 GF

CONTROL ROOM
05 GF

TRANSFORMER ROOM
03 GF

ELECTRICAL ROOM
02 GF

TOILET
06 GF

NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

LEGEND
1 ----------
2 ----------
3 ----------
4 ----------
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6 ----------

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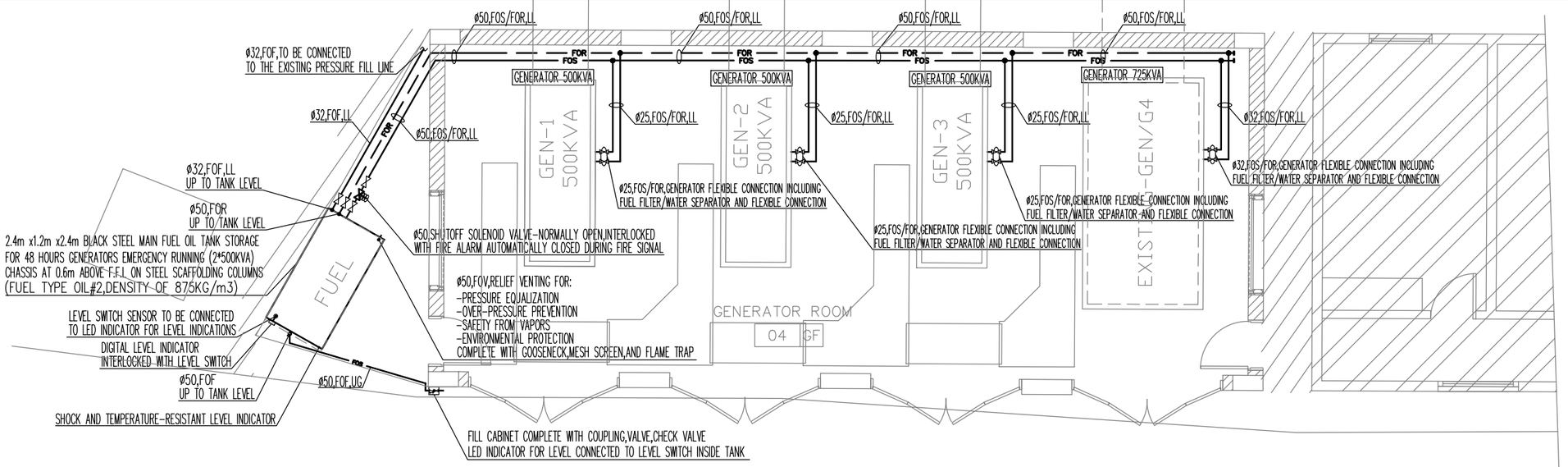
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4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

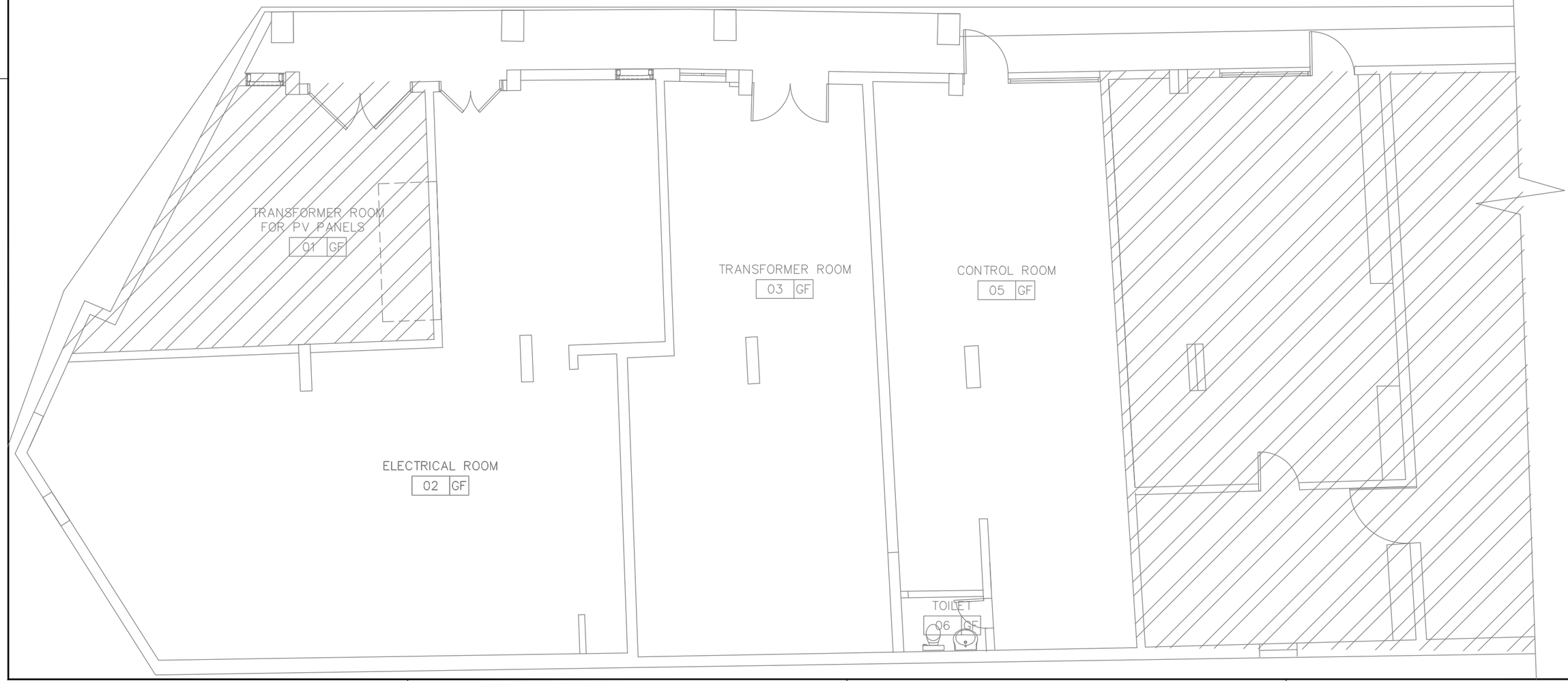
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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
GROUND FLOOR PLAN – FIRE FIGHTING LAYOUT

SCALE:	1/50
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	A0 A1 A2 A3 A4
PROJ. No.:	DWG. No.:
L2026-14	M-306
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-M306

FUEL OIL AND GAS ABBREVIATIONS	
LL	LOW LEVEL
h	HOUR
GEN	GENERATOR
F.F.L	FINISH FLOOR LEVEL
KVA	KILOVOLT-AMPERES
FOS	FUEL OIL SUPPLY PIPE
FOF	FUEL OIL FILL PIPE
FOV	FUEL OIL VENT PIPE
FOR	FUEL OIL RETURN PIPE
m	METER
L	LITER
m3	CUBIC METER
KG/m3	KILOGRAM PER CUBIC METER
UG	UNDERGROUND
∅	PIPE DIAMETER
#	NUMBER
o—	PIPE RISE
o—	PIPE DROP





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2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND

1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE

GENERAL DIRECTORATE BAABDA, LEBANON

MAIN ELECTRICAL / GENERATOR ROOMS

GROUND FLOOR PLAN – FUEL OIL LAYOUT

SCALE:	1/50
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	A4 A3 A2 A1 A0
PROJ. No.:	DWG. No.:
L2026-14	M-307
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-M307

THE TOTAL EXTERNAL STATIC PRESSURE ACROSS THE GENERATOR RADIATOR AIR PATH SHALL NOT EXCEED THE GENERATOR MANUFACTURER'S ALLOWABLE LIMIT TO ENSURE ADEQUATE AIRFLOW AND PROPER OPERATION OF THE BUILT-IN RADIATOR COOLING FANS

HVAC ABBREVIATIONS	
CDP	CONDENSATE DRAIN
DN	DOWN
DX	DIRECT EXPANSION
HL	HIGH LEVEL
EAD	EXTRACT AIR DUCT
EXF	EXTRACT FAN
FAL	FRESH AIR LOUVER
MFDR	MOTORIZED FIRE DAMPER
TR	TON REFRIGERATION
CFM	CUBIC FEET PER MINUTE
OU	OUTDOOR UNIT
IU	INDOOR UNIT
UT	UNDER TILE
PVC	POLYVINYL CHLORIDE
RS/RL	UNDER TILE
KVA	KILOVOLT-AMPERES
(TS)	TEMPERATURE SENSOR
(T)	THERMOSTAT
W	WATT
°C	DEGREE CELSIUS
mm	MILLIMETER
m	METER
Kg/m3	KILOGRAM PER CUBIC METER
m/s	METER PER SECOND
ø	PIPE DIAMETER

BUILT-IN COOLING RADIATOR FAN 20000 CFM COVERING 500 KVA

BUILT-IN COOLING RADIATOR FAN 20000 CFM COVERING 500 KVA

BUILT-IN COOLING RADIATOR FAN 20000 CFM COVERING 500 KVA

BUILT-IN COOLING RADIATOR FAN 40000 CFM COVERING 750 KVA

1 EXHAUST FLUE PIPES 2m ABOVE ROOF LEVEL COMPLETE WITH RAIN CAP/WEATHER HOOD AT TERMINATION

2 ø250 SEAMLESS BLACK STEEL, SCHEDULE 40 EXHAUST FLUE PIPES OF 4mm MINIMUM THICKNESS

3 DIESEL OXIDATION CATALYST FILTRATION UNIT SUITABLE FOR 500KVA GENERATOR OPERATION

4 MUFFLER SILENCER ACOUSTIC INSULATION COMPLETE WITH SPARK ARRESTOR AND FLEXIBLE CONNECTOR

5 ø50mm THICK MINERAL WOOL/ROCK WOOL INSULATION (DENSITY 80-120 kg/m3) COMPLETE WITH ALUMINUM CLADDING

6 FLEXIBLE STAINLESS STEEL ELBOWS CONNECTION AT GENERATOR OUTLET

GEN-1 500KVA GENERATOR-500KVA

GEN-2 500KVA GENERATOR-500KVA

GEN-3 500KVA GENERATOR-500KVA

GENERATOR-725KVA

EXISTING GEN/G4

GENERATOR ROOM 04 GF

IN1=2.25
TOP2=4.35

FUEL

EXHAUST FLUE PIPES 2m ABOVE ROOF LEVEL COMPLETE WITH RAIN CAP/WEATHER HOOD AT TERMINATION

ø300 SEAMLESS BLACK STEEL, SCHEDULE 40 EXHAUST FLUE PIPES OF 4mm MINIMUM THICKNESS

DIESEL OXIDATION CATALYST FILTRATION UNIT SUITABLE FOR 725KVA GENERATOR OPERATION

MUFFLER SILENCER ACOUSTIC INSULATION COMPLETE WITH SPARK ARRESTOR AND FLEXIBLE CONNECTOR

ø50mm THICK MINERAL WOOL/ROCK WOOL INSULATION (DENSITY 80-120 kg/m3) COMPLETE WITH ALUMINUM CLADDING

FLEXIBLE STAINLESS STEEL ELBOWS CONNECTION AT GENERATOR OUTLET

THE REQUIRED TOTAL COOLING AIR FLOW FOR OPERATING 2*500KVA OR 1*725KVA GENERATORS IS 40000 CFM

2000x2200,FAL+FILTER/2000x2200,MFDR
0.37 FREE AREA RATIO @ 2.5m/s VELOCITY

AIRTIGHT INSULATED STEEL DOOR COMPLETE WITH PERIMETER RUBBER GASKETS AND AUTOMATIC DROP SEAL

2800x1000,FAL+FILTER/2800x1000,MFDR
0.37 FREE AREA RATIO @ 2.5m/s VELOCITY

AIRTIGHT INSULATED STEEL DOOR COMPLETE WITH PERIMETER RUBBER GASKETS AND AUTOMATIC DROP SEAL

2800x1000,FAL+FILTER/2800x1000,MFDR
0.37 FREE AREA RATIO @ 2.5m/s VELOCITY

AIRTIGHT INSULATED STEEL DOOR COMPLETE WITH PERIMETER RUBBER GASKETS AND AUTOMATIC DROP SEAL

2800x1000,FAL+FILTER/2800x1000,MFDR
0.37 FREE AREA RATIO @ 2.5m/s VELOCITY

AIRTIGHT INSULATED STEEL DOOR COMPLETE WITH PERIMETER RUBBER GASKETS AND AUTOMATIC DROP SEAL

2000x2200,FAL+FILTER/2000x2200,MFDR
0.37 FREE AREA RATIO @ 2.5m/s VELOCITY

AIRTIGHT INSULATED STEEL DOOR COMPLETE WITH PERIMETER RUBBER GASKETS AND AUTOMATIC DROP SEAL

2800x1000,FAL+FILTER/2800x1000,MFDR
0.37 FREE AREA RATIO @ 2.5m/s VELOCITY

AIRTIGHT INSULATED STEEL DOOR COMPLETE WITH PERIMETER RUBBER GASKETS AND AUTOMATIC DROP SEAL

MOTORIZED FIRE DAMPERS INTERLOCKED WITH THE FIRE ALARM/FIRE SUPPRESSION SYSTEM AND SHALL AUTOMATICALLY CLOSE UPON ALARM ACTIVATION OR POWER FAILURE (FAIL-SAFE CLOSED)

900x1900,FAL+FILTER/900x1900,MFDR
0.37 FREE AREA RATIO @ 2.5m/s VELOCITY
RECOMMENDED AIR FLOW=3400 CFM

EXISTING LOUVER SHALL BE REMOVED

CP-01
CONTROL PANEL INCLUDING IN PHASE 1

AIRTIGHT INSULATED STEEL DOOR COMPLETE WITH PERIMETER RUBBER GASKETS AND AUTOMATIC DROP SEAL

EXISTING DX SPLIT UNIT SHALL BE REMOVED

TRANSFORMER ROOM FOR PV PANELS 01 GF

TRANSFORMER ROOM 03 GF

ELECTRICAL ROOM 02 GF

COOLING LOAD ESTIMATION 0.05TR/m2

IU(DX)-2.0

IU(DX)-2.0

ø32,CDP

750x400,EAD,UP TO ROOF LEVEL
OPENING SHALL BE COMPLETED WITH WIRE MESH

RS/RL,UP

RL/RS

RL/RS

ø50,CDP

ø150,PVC,UP

ø150,PVC,HL

EXF-75 (WALL MOUNTED)

ø50,CDP TO BE CONNECTED TO THE NEAREST PIPE

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4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND
1 –
2 –
3 –
4 –
5 –
6 –

NOTES
1 – XXXXX
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4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
GROUND FLOOR PLAN – HVAC LAYOUT

SCALE:	1/50
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR.
APP'D:	
SHEET SIZE A:	A1
PROJ. No.:	L2026-14
DWG. No.:	M-308
APP'D FOR CONSTRUCTION :	

COMPUTER CODE No.: L2026-14-M308

HVAC ABBREVIATIONS	
CDP	CONDENSATE DRAIN
DN	DOWN
DX	DIRECT EXPANSION
HL	HIGH LEVEL
EAD	EXTRACT AIR DUCT
EXF	EXTRACT FAN
FAL	FRESH AIR LOUVER
MFDR	MOTORIZED FIRE DAMPER
TR	TON REFRIGERATION
CFM	CUBIC FEET PER MINUTE
OU	OUTDOOR UNIT
IU	INDOOR UNIT
UT	UNDER TILE
PVC	POLYVINYL CHLORIDE
RS/RL	UNDER TILE
KVA	KILOVOLT-AMPERES
TS	TEMPERATURE SENSOR
T	THERMOSTAT
W	WATT
°C	DEGREE CELSIUS
mm	MILLIMETER
m	METER
Kg/m3	KILOGRAM PER CUBIC METER
m/s	METER PER SECOND
ø	PIPE DIAMETER

EXHAUST FLUE PIPES 2m ABOVE ROOF LEVEL
COMPLETE WITH RAIN CAP/WEATHER HOOD AT TERMINATION

EXHAUST FLUE PIPES 2m ABOVE ROOF LEVEL
COMPLETE WITH RAIN CAP/WEATHER HOOD AT TERMINATION

EXHAUST FLUE PIPES 2m ABOVE ROOF LEVEL
COMPLETE WITH RAIN CAP/WEATHER HOOD AT TERMINATION

EXHAUST FLUE PIPES 2m ABOVE ROOF LEVEL
COMPLETE WITH RAIN CAP/WEATHER HOOD AT TERMINATION

FUEL

EXF-3400 (3400CFM),LOCATED AT ROOF LEVEL
EXHAUST FAN SHALL BE AUTOMATICALLY CONTROLLED
BY A ROOM TEMPERATURE SENSOR/THERMOSTAT
FAN SHALL START AT 40°C AND STOP AT 30°C (ADJUSTABLE)

EXISTING FAN SHALL BE REMOVED
OPENING SHALL BE PROPERLY CLOSED AT ROOF

750x400,EAD AT ROOF LEVEL COMPLETE WITH WIRE MESH

OU(DX)-2.0 OU(DX)-2.0

RS/RL,DN
ø150,PVC,DN

ø150,PVC, AT ROOF LEVEL COMPLETE WITH WIRE MESH

750x400,EAD,DN

NOTES
1 - XXXXX
2 - XXXXX
3 - XXXXX
4 - XXXXX
5 - XXXXX
6 - XXXXX

LEGEND
1 ----------
2 ----------
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5 - XXXXX	Rev5	X.X	X/XX/XX
6 - XXXXX	Rev6	X.X	X/XX/XX

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PRESIDENTIAL PALACE

GENERAL DIRECTORATE BAABDA, LEBANON

MAIN ELECTRICAL / GENERATOR ROOMS

ROOF FLOOR PLAN - HVAC LAYOUT

SCALE:	1/50
DATE:	SEP-2026
DRAWN:	A.S.
CHECKED:	A.MR
APP'D:	
SHEET SIZE A:	A1
PROJ. No.:	DWG. No.:
L2026-14	M-309
APP'D FOR CONSTRUCTION :	

COMPUTER CODE No.: L2026-14-M309

LIGHTING FIXTURE LEGEND

	TYPE C: Ceiling mounted luminaire aluminum or steel body electrostatically painted in white color,louver with 24W T8, 120 Lm/W, IP-20, 4000K, CR1-80, operation life 50000 hours , 5 years warranty
	TYPE C: Ceiling mounted luminaire aluminum or steel body electrostatically painted in white color,louver with 24W T8, 120 Lm/W, IP-55, 4000K, CR1-80, operation life 50000 hours , 5 years warranty
W	TYPE W: 100W LED projector module wall mounted. Die-cast aluminum housing with high corrosion resistance. Extruded aluminum structure. Stone wash surface treatment and silicone gasket, 100 lm/W, 3500K, IP65, IK10, 95 CRI.
EM	TYPE EM: Emergency Non Maintained luminaire made with high-technology LED-lamp, up to 30000 hours service, has a matte cover and provides a uniform lighting with built in battery for 3 hours. 11W, IP54, 338lm, 4000K, 85 CRI.
	TYPE EX: EXIT SIGN LED LIGHT WALL / CEILING MOUNTED MAINTAINED, 10W - 450 LM DURATION 1.5H, POLYCARBONATE HOUSING IP 65 - WITH ENGRAVED LETTERS ON FIXTURES.
	TYPE EX: EXIT SIGN DIRECTIONAL - ONE WAY LED LIGHT WALL / CEILING MOUNTED MAINTAINED, 10W - 450 LM DURATION 1.5H, POLYCARBONATE HOUSING IP 65 - WITH ENGRAVED LETTERS ON FIXTURES.

ELECTRICAL LEGEND

	16Amp Simplex Socket Wall Mounted H=45CM F.F.L
	16Amp 3Phase socket H=120cm F.F.L
	10Amp One Way One Gang H=120cm F.F.L
a,b	10Amp One Way Two Gang H=120cm F.F.L
	10Amp One Way One Gang H=120cm F.F.L Waterproof
	10Amp One Way Two Gang H=120cm F.F.L Waterproof
a,b,c	10Amp One Way Three Gang H=120cm F.F.L. ANTI-BACTERIAL
	10Amp Two Way One Gang H=120cm F.F.L. ANTI-BACTERIAL
DB-	Distribution Board
SMDB	Sub-Main Distribution Board 800Amps max
CP	CONTROL PANEL
M.D.B	Main Distribution Board 8 Outgoing max
LSP–	Lighting Switch Panel
	Disconnect Switch Waterproof Rating Indicated On Drawings.
INTERFACE WITH DH FIRE ALARM	CONTACTOR Three PHASE 40AMP

FIRE ALARM LEGEND

H	ADDRESSABLE HEAT DETECTOR CEILING MOUNTED.
HS	ADDRESSABLE HEAT-SMOKE DETECTOR CEILING MOUNTED.
F	ADDRESSABLE MANUAL FIRE ALARM STATION, H =140cms.
F.B	ADDRESSABLE FIRE BELL with strobe light, H=240cm F.F.L
FACP	ADDRESSABLE FIRE ALARM CONTROL PANEL, H=180cm F.F.L
CM	ADDRESSABLE CONTROL MODULE.
	FLASHER LIGHT VISUAL ALARM WATER PROOF

COMMUNICATION LEGEND

	RJ45 Data Outlet Wall Mounted H:45cm F.F.L
-U DATA RACK	Data Rack
	RJ11 Telephone Outlet Wall Mounted H:120cm F.F.L
CONSOLE	CCTV CONSOLE
N.V.R	Network Video Recorder
	5 MP dome with 360° panoramic view for all light conditions
FIX.C	8 MP resolution and in 16:9 format Fixed surveillance CCTV.
TV.B–1	SET TOP OF BOX(TELEVISION BOX)
TV	WALL MOUNTED TELEVISION OUTLET

WIRE SIZE	CONDUIT SIZE & WIRES NUMBER		
mm2	20mm.	25mm.	32mm.
1.5	7	12	-
2.5	5	9	12
4	3	6	9
6	-	5	8
10	-	3	6
16	-	-	4
25	-	-	3

LEGEND

MCC	MOTOR CONTROL CENTER
CP	CONTROL PANEL
FACP	FIRE ALARM CONTROL PANEL
CHWP	CHILLED WATER PUMP
DB	DISTRIBUTION BOARD
UDB	DISTRIBUTION BOARD UPS
SMDB	SUB MAIN DISTRIBUTION BOARD
USMDB	SUB MAIN DISTRIBUTION BOARD UPS
LVP	LOW VOLTAGE PANEL
MV	MEDIUM VOLTAGE
DS	DISCONNECT SWITCH
MDB	MAIN DISTRIBUTION BOARD
MCB	MOLDED CIRCUIT BREAKER
MCCB	MOLDED CASE CIRCUIT BREAKER

LIGHTNING LEGEND

	AIR TERMINAL h=5m
DC	DOWN CONDUCTOR 25X3mm
	LIGHTNING EARTH PIT

Note:

1. ALL DATA OUTLET DEVICES SHALL BE CONNECTED TO DATA RACK THROUGHT CAT-6 CABLE
2. ALL TELEPHONE OUTLET DEVICES SHALL BE CONNECTED TO TELEPHONE TERMINAL CABINET THROUGH CAT-3 CABLE

GENERAL NOTES:

1. THE FOLLOWING NOTES SHALL APPLY TO ALL THE ELECTRICAL DRAWING AS APPLICABLE UNLESS OTHERWISE INDICATED OR NOTED.
2. DO NOT SCALE FROM THE LAYOUT DRAWINGS, WORK ACCORDING TO ARCHITECTURAL & ELECTRICAL DETAILS UNLESS OTHERWISE AUTHORIZED.
3. THE ELECTRICAL DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE REST OF THE DRAWINGS (ARCHITECTURE, STRUCTURE, AIR CONDITIONING, PLUMBING, DECORATION) , B.O.Q AND THE SPECIFICATIONS, AS APPLICABLE.
4. ALL DIMENSIONS SHOWN ON DETAILS ARE IN cm UNLESS OTHERWISE INDICATED.
5. ALL EXPOSED CONDUITS ABOVE FALSE CEILING , IF EXIST, WHEN RUN BELOW FALSE CEILING SHALL BE CONCEALED IN WALLS.
6. EQUIPMENT GROUNDING (EARTH CONTINUITY) CONDUCTORS ARE NOT ON SINGLE LINE DIAGRAMS THEY SHALL BE READ IN ACCORDANCE WITH THE SPECIFICATIONS.
7. LIGHTING POINTS AND JUNCTION BOXES SHALL BE CONCEALED IN CONFORMANCE WITH ASSOCIATED CONDUITS.
8. PENDENT LIGHTING POINT SHALL CONSIST OF A CEILING ROSE, FLEXIBLE CORD, A LAMP HOLDER OR LIGHTING FIXTURES TYPE AS INDICATED IN THE LIGHTING SCHEDULE & LIGHTING LAYOUTS.
9. SHAPE AND DIMENSION OF SYMBOLS USED FOR LED AND / OR OTHER FIXTURES DO NOT NECESSARILY REPRESENT SHAPE AND DIMENSIONS OF ACTUAL FIXTURE INTENDED. FOR THIS PURPOSE REFER TO LIGHTING FIXTURES SCHEDULE AND SPECIFICATIONS.
10. OUTLET BOX FOR FALSE CEILING MOUNTED LIGHTING FIXTURE SHALL BE POSITIONED IN SUCH A WAY IT WILL NOT BE OBSTRUCTED BY A/C DUCTS, PIPES, ETC... THE ELECTRICAL CONTRACTOR SHALL COORDINATE WITH THE A/C AND PLUMBING CONTRACTOR FOR THIS PURPOSE, PRIOR TO INSTALLING THE BOXES.
11. LIGHTING FIXTURES MOUNTED IN FALSE CEILING SHALL BE FED THROUGH AN EXPOSED LIGHTING OUTLET (ABOVE FALSE CEILING) CEILING ROSE AND HEAT RESISTANT FLEXIBLE CORD AS SPECIFIED.
12. LIGHTING SWITCHES IN BEDROOM NEAR BED ,IF EXIST, SHALL BE LOCATED AT H=65 LIGHTING SWITCHES NEAR DOORS SHALL BE INSTALLED AT 8cm. FROM ARCHITRAVE (MEASURED FROM THE EDGE OF SWITCH).
13. RECEPTACLES (SOCKET OUTLETS) SHALL BE LOCATED AT H=45 CM AS INDICATED ABOVE EXCEPT IN THE BEDROOM NEAR BED SHALL BE AT H=65 CM F.F.L. OR OTHERWISE INDICATED.
14. THE MINIMUM CONDUIT SIZE USED SHALL BE No.Ø20mm. FOR LIGHTING No.Ø25mm.
15. TELEPHONE CONDUIT SIZES SHALL BE MINIMUM Ø20mm FOR 1 & 2 WIRES & Ø25mm. FOR 3 & 4 WIRES.
16. MINIMUM CONDUIT SIZE FOR DATA SYSTEM IS Ø25mm.
17. STARTERS SHALL HAVE POWER RATING NOT SMALLER THAT THE POWER RATING OF THE RELEVANT MOTOR.
18. THE CONTRACTOR SHALL PROVIDE ALL NECESSARY CONDUITS OUTLETS BOXES FOR LIFT SIGNAL EQUIPMENT (CALL BUTTONS, POSITION INDICATORS, ETC...) AS REQUIRED.
19. ALL CONDUCTORS SHOWN ARE SINGLE CORE IN CONDUITS UNLESS INDICATED ARM OR OTHERWISE.
20. LOCATION OF JUNCTION & PULL BOXES SHALL BE TO THE APPROVAL OF THE ENGINEER.
21. EACH CONDUIT SHALL CONTAIN ONLY ONE CIRCUIT, IF WE NEED MORE FOR COMMON EQUIPMENT,ADDITIONAL CONDUITS RUN IN PARALLEL.
22. ALL CONTROL WIRES BETWEEN EQUIPMENT SUPPLIED UNDER THE MECHANICAL ALL MOTORS STARTERS & OTHER THREE PHASE EQUIPMENT MAY HAVE THEIR CONTROL ON 220 VOLTS.
23. SIZE AT NO EXTRA COST THREE PHASE HEATERS ARE ASSUMED TO BE DELTA CONNECTED.
24. THE CONTRACTOR SHALL OTHERWISE PROVIDE A FULL SIZE NEUTRAL IN THE CIRCUIT AT NO EXTRA COST THE TERMINAL LUGS OF ALL CIRCUIT BREAKERS & DISCONNECTING SWITCHES CABLES AS INDICATED ON THE DWGS.
25. THE MIGHT NECESSITATE OFF-STANDARD CONDUIT FOR POWER & LIGHTING WIRES & CABLES SHALL HAVE SIZES AS TABULATED OVER SIZING.

NB: REPRODUCTION AND USE OF THESE DOCUMENTS IS PROHIBITED WITHOUT WRITTEN PERMISSION OF THE DESIGNER

REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

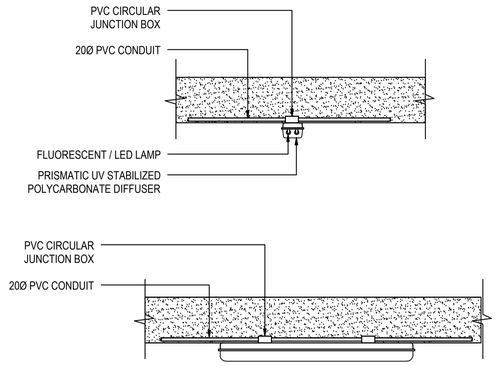
NOTES
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LEGEND
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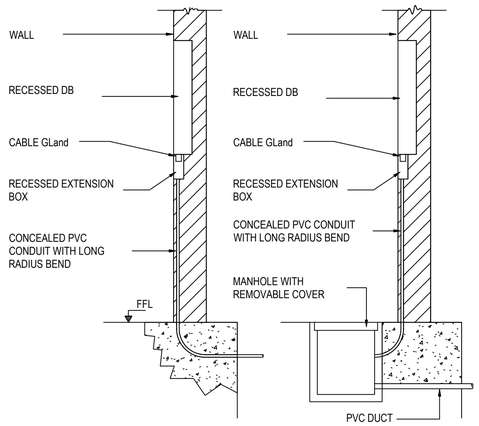
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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
ELECTRICAL LEGEND

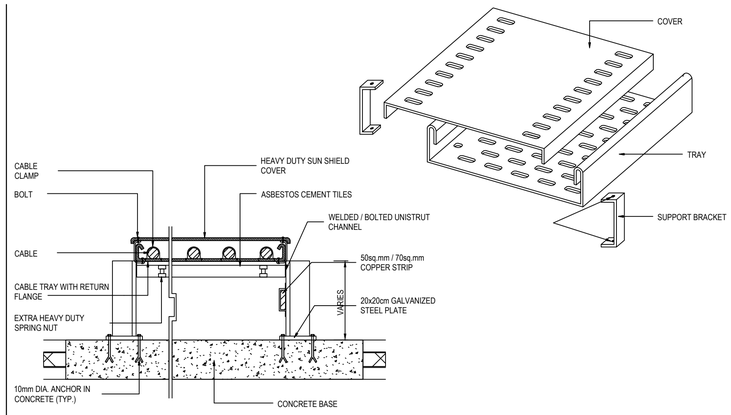
SCALE:	NO
DATE:	OCT–2026
DRAWN:	A.F
CHECKED:	M.H
APP'D:	A.SH
SHEET SIZE A:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026–14	E–401R1
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	L2026-14-E-401R1



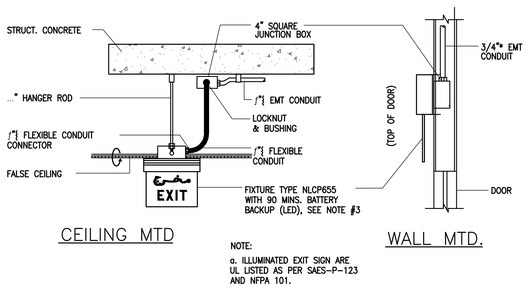
FLUORESCENT \ LED FIXTURE MOUNTING



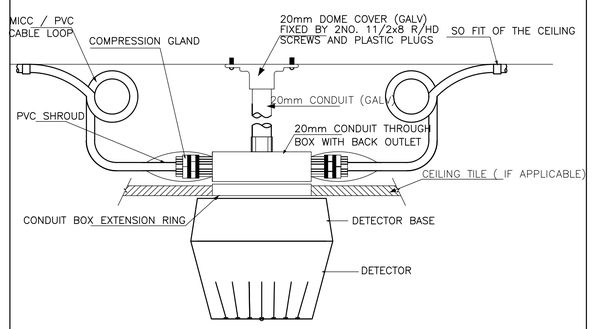
TYPICAL CABLE ENTRY FROM BELOW TO RECESSED DB



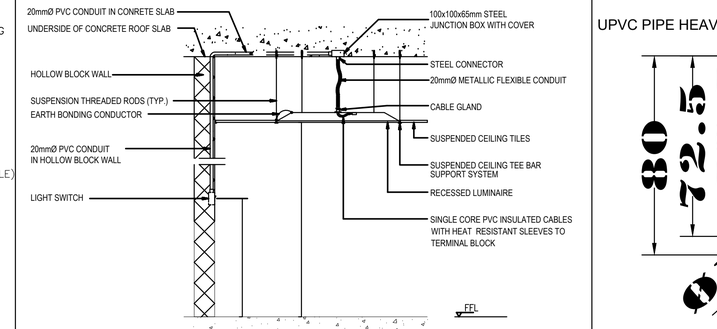
CABLE TRUNK TYPICAL DETAILS



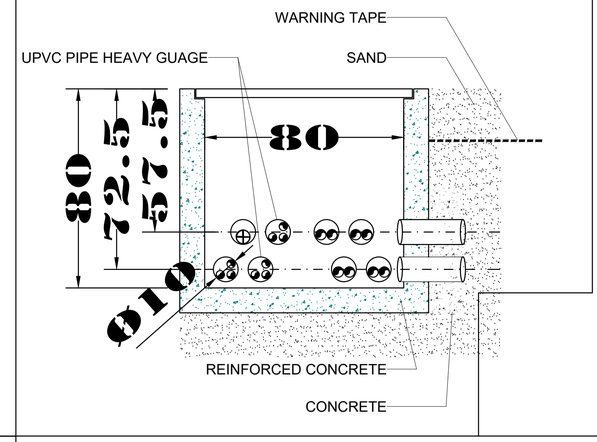
EXIT LIGHT SIGNAGE MOUNTING



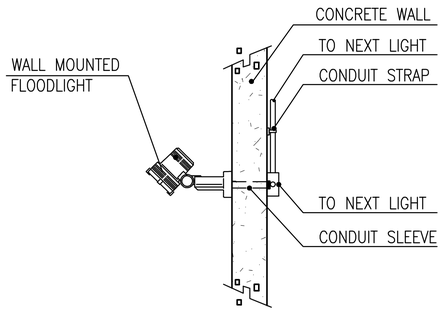
STD. MOUNTING DETAILS FOR SMOKE OR HEAT DETECTOR



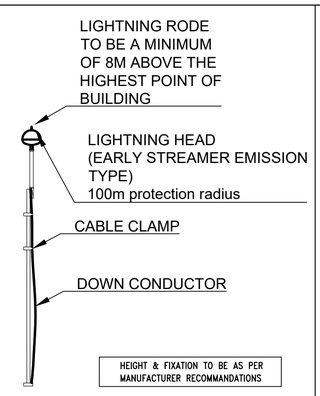
60x60CM RECESSED FIXTURE MOUNTED IN SUSPENDED CEILING



80CM HAND HOLE TYPICAL SECTION

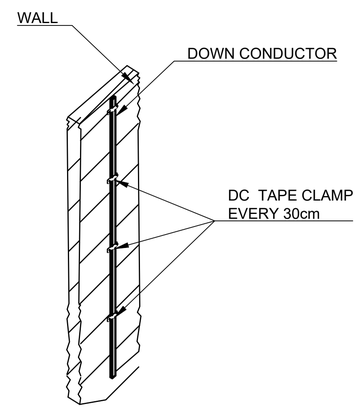


WALL MOUNTED FLOODLIGHT



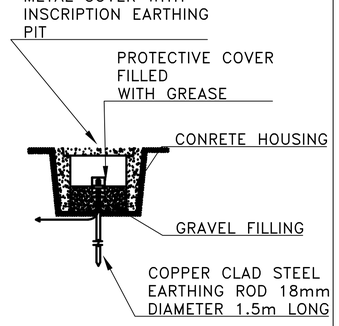
LIGHTNING HEAD (EARLY STREAMER EMISSION TYPE)

DETAIL–1–



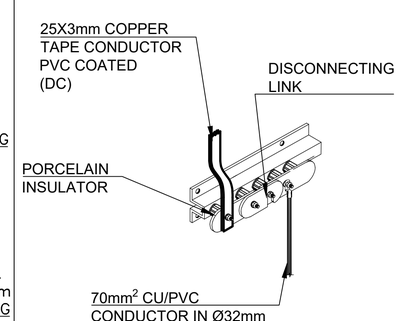
BARE COPPER TAPE INSTALLATION ON WALL

DETAIL–2–



EARTH PIT

DETAIL –3–



TO BE MOUNTED IN GALAVANIZED
STEEL INSPECTION BOX

LIGHTNING BAR

DETAIL –4–

NB: REPRODUCTION AND USE OF THESE DOCUMENTS IS PROHIBITED WITHOUT WRITTEN PERMISSION OF THE DESIGNER

REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND

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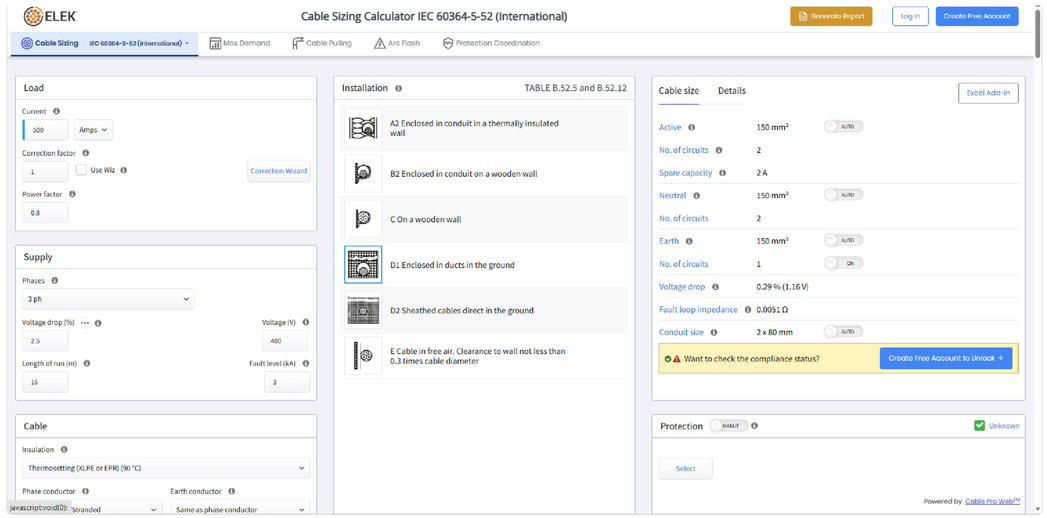
NOTES

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3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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BEIRUT – LEBANON

PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
ELECTRICAL GENERAL DETAILS

SCALE:	NO
DATE:	OCT–2026
DRAWN:	A.F
CHECKED:	M.H
APP'D:	A.SH
SHEET SIZE A:	A1
PROJ. No.:	DWG. No.:
L2026–14	E–402R1
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	2026-14-E-402R1



PRESIDENTIAL PALACE

ABLE DESCRIPTION PHASE 2 Jul-26

POWER CABLE FOR RESEAU RES-3-4							
N	CABLE	FROM	TO	SUPPLY	NUMBER OF SET	LENGTH (m)	TOTAL LENGTH (m)
1	4CX120mm²	RES-3	JUNCTION BOX R-3	GARDEN	1	24	24
2	4CX150mm²	RES-3	JUNCTION BOX R-3	CAFETERIA GAS STATION & THE CLINIC	1	24	24
3	4CX25mm²	RES-3	JUNCTION BOX R-3	WATER FOUNTAIN Nb 3	2	24	48
4	4CX25mm²	RES-3	JUNCTION BOX R-3	Guards	1	24	24
5	4CX25mm²	RES-3	JUNCTION BOX R-3	president aide	1	24	24
6	4CX25mm²	RES-3	JUNCTION BOX R-3	office nb2	1	24	24
7	4CX25mm²	RES-3	JUNCTION BOX R-3	A/C Office	1	24	24
8	4CX25mm²	RES-3	JUNCTION BOX R-3	battalion	1	24	24
9	4CX16mm²	RES-3	JUNCTION BOX R-3	ROAD BLOCK Nb3	1	24	24
10	4CX25mm²	RES-3	JUNCTION BOX R-3	offices nb 12	1	24	24
11	4CX25mm²	RES-3	JUNCTION BOX R-3	DB-R-3	1	24	24
12	4CX150mm²	RES-4	JUNCTION BOX R-4	build nb 4	1	30	30
13	4CX6mm²	RES-4	JUNCTION BOX R-4	Cafeteria in the palace	1	30	30
14	4CX6mm²	RES-4	DB-G	Generator room	1	30	30
15	4CX6mm²	RES-4	DB-GS	Main electrical room	1	20	20

TOTAL FOR CABLE 4CX150mm²	**54m**
TOTAL FOR CABLE 4CX120mm²	**24m**
TOTAL FOR CABLE 4CX25mm²	**192m**
TOTAL FOR CABLE 4CX16mm²	**24m**
TOTAL FOR CABLE 4CX6mm²	**80m**

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3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

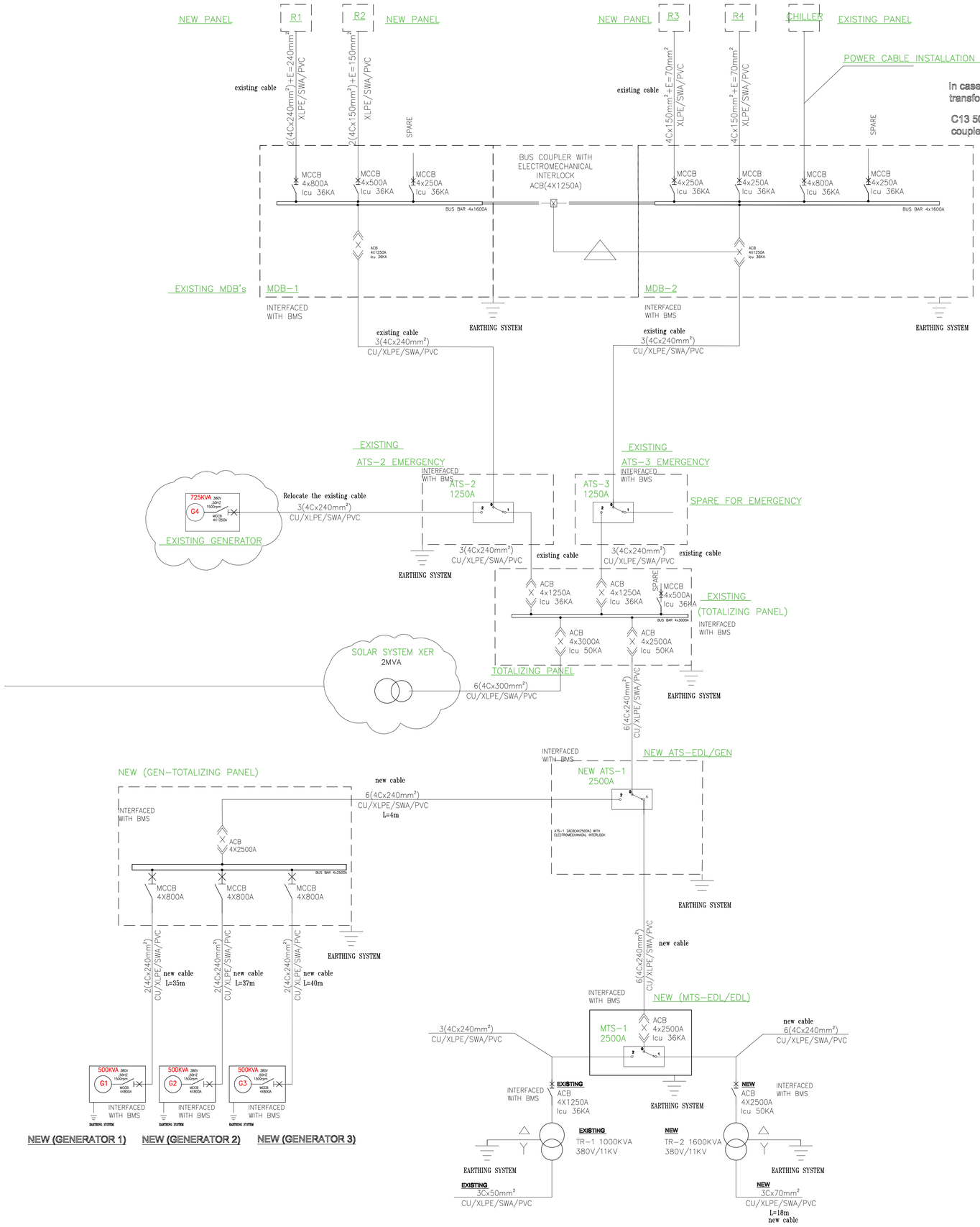
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LEGEND
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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
ELECTRICAL CALCULATION REPORT

SCALE:	NO
DATE:	OCT–2026
DRAWN:	A.F
CHECKED:	M.H
APP'D:	A.SH
SHEET SIZE A:	A3
PROJ. No.:	DWG. No.:
L2026–14	E–403R1
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	2026-14-E-403R1



Note: The contactor **C13** for chiller should be programmed to open when ATS–2 is switched to the position of G4.

Note: the solar system controller must control the maximum power export to the grid to not exceed 80% OF capacity of the EDL transformer

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND
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NOTES
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4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
ELECTRICAL RISER DIAGRAM PHASE 2

SCALE:	no
DATE:	OCT–2026
DRAWN:	A.F.
CHECKED:	M.H.
APP'D:	A.SH.
SHEET No.:	4 / 7 / 1 / 8
PROJ. No.:	DWG. No.:
L2026–14	E–404R1

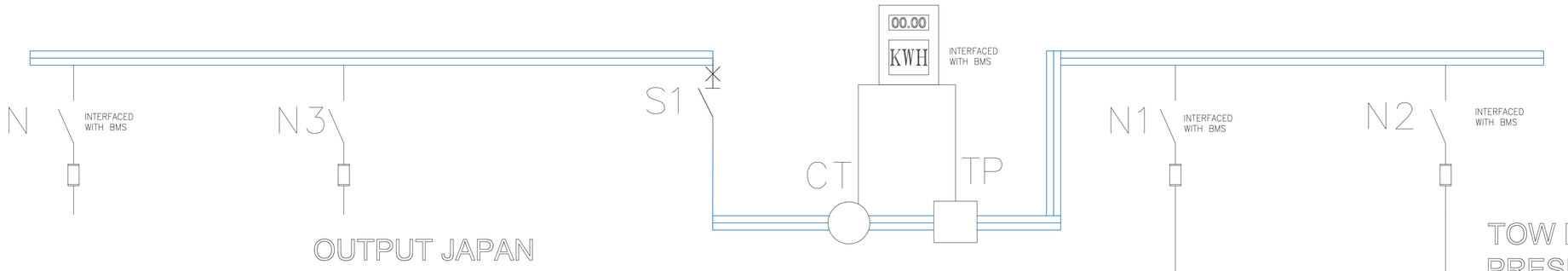
APP'D FOR CONSTRUCTION :

COMPUTER CODE No.: L2026–14–A112

MEDIUM VOLTAGE

copper busbar could be 60 × 10 mm

EDL KWH METER



N1 Switchgear with SF6 Circuit Breakers

S1 Switchgear 11KV - 600AMP

Rehabilitation of Existing 11 kV MV Switchgear and Protection System – Carry out the complete rehabilitation of the existing 11 kV switchgear, including inspection, dismantling where required, cleaning, servicing, repair and replacement of defective or obsolete components. The work shall include circuit new breaker ,current and voltage transformer and protection relays

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1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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MAIN ELECTRICAL / GENERATOR ROOMS
MV RISER DIAGRAM

SCALE:	no
DATE:	OCT–2026
DRAWN:	A.F.
CHECKED:	M.H.
APPVD:	A.SH.
DRG. No.:	1 / 1 / 1 / 0
PROJ. No.:	DWG. No.:
L2026-14	E-405R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. | 2026-14-A112

Load Distribution Schedule

Project / Building Name:TL-2797 | **MAIN C.B : 25 AT / 100 AF, 3P** | **FEED FROM :** RES-4
Address / Location: ELECTRICAL ROOM | **VOLTAGE : 380/220V,3-PH,50Hz** | **FEEDER SIZE :** 4C-6mm² PVC/PVC+1-6mm² PVC G.
Distribution Board No / Ref: DB-G | **WAYS : 24** | **DISTANCE :** 30m
LOCATION: GROUND FLOOR | **%V.D. :**

			CCT.ref.No	MCB rating (A)	Phase & Neutral Size mm²	Earth Size mm²	No. of Ways	DESCRIPTION	CirXLPEit Load in (W) R	Y	B	CONDUIT SIZE
1	4P 25A 10 kA MCB	Section 1 - 300mA RCD 16A 3ph	R1	10A			SPARE		0			
2			Y1	10A	2.5 MM²	2.5 MM²	LIGHTING	GENERATOR ROOM		192		20MM
3			B1	10A	2.5 MM²	2.5 MM²	LIGHTING	GENERATOR ROOM			192	20MM
4			R2	10A			SPARE		0			
5			Y2	10A	2.5 MM²	2.5 MM²	LIGHTING	OUTDOOR		300		20MM
6			B2	10A	2.5 MM²	2.5 MM²	LIGHTING	ALL EMERGENCY AND EXIT			50	20MM
7		Section 2 - 300mA RCD 20A 3ph	R3	16A	4 MM²		SOCKET	GENERATOR ROOM	500			25MM
8			Y3	16A			SOCKET			500		25MM
9			B3	16A			SOCKET				500	25MM
10			R4	16A	4 MM²	4 MM²	SOCKET	GENERATOR ROOM	900			25MM
11			Y4	16A			SPARE			0		
12			B4	16A			SPARE				0	

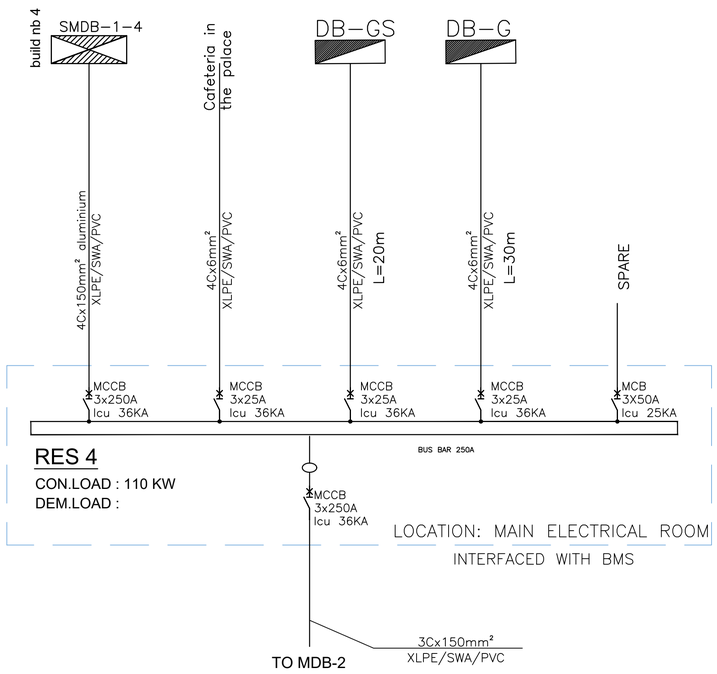
CONNECTED LOAD PHASE "R" =	***1400 W***	TOTAL CONNECTED LOAD (KW) =	***3.1***	TOTAL CONNECTED CURRENT "I"	***5.95***		LTG.	S.O	HVAC	KIT. EQP	EWH	TOTAL
CONNECTED LOAD PHASE "Y" =	***992 W***	DEMAND FACTOR =	***67%***	TOTAL DEMAND CURRENT "I"	***3.99***	CONN.KW	0.73	2.40	0.00	0.00	0.00	3.13
CONNECTED LOAD PHASE "B" =	***742 W***	TOTAL DEMAND LOAD (KW) =	***2.1***	TOTAL DEMAND CURRENT "I"	***4.39***	DEM.FACT	90.0%	60.0%	60.0%	80.0%	100.0%	67.0%
TOTAL CONNECTED LOAD =	***3134 W***	TOTAL DEMAND LOAD (KW) =	***2.3***	WITH 10% SPARE		DEM.KW	0.66	1.44	0.00	0.00	0.00	2.10
BALANCE : 47.00%		WITH 10% SPARE										

Load Distribution Schedule

Project / Building Name:TL-2797 | **MAIN C.B : 25 AT / 100 AF, 3P** | **FEED FROM :** RES-4
Address / Location: ELECTRICAL ROOM | **VOLTAGE : 380/220V,3-PH,50Hz** | **FEEDER SIZE :** 4C-6mm² PVC/PVC+1-6mm² PVC G.
Distribution Board No / Ref: DB-GS | **WAYS : 30** | **DISTANCE :** 20m
LOCATION: GROUND FLOOR | **%V.D. :**

			CCT.ref.No	MCB rating (A)	Phase & Neutral Size mm²	Earth Size mm²	No. of Ways	DESCRIPTION	CirXLPEit Load in (W) R	Y	B	CONDUIT SIZE
1	4P 25A 10 kA MCB	Section 1 - 300mA RCD 16A 3ph	R1	10A	2.5 MM²	2.5 MM²	LIGHTING	CORRIDOR	72			20MM
2			Y1	10A	2.5 MM²	2.5 MM²	LIGHTING	TRANSFORMER ROOM FOR PV		144		20MM
3			B1	10A	2.5 MM²	2.5 MM²	LIGHTING	ELECTRICAL ROOM			192	20MM
4			R2	10A	2.5 MM²	2.5 MM²	LIGHTING	ELECTRICAL ROOM	192			20MM
5			Y2	10A	2.5 MM²	2.5 MM²	LIGHTING	TRANSFORMER ROOM		216		20MM
6			B2	10A	2.5 MM²	2.5 MM²	LIGHTING	CONTROL ROOM +TOILET			155	20MM
7		Section 2 - 300mA RCD 20A 3ph	R3	16A			SPARE		0			
8			Y3	10A	2.5 MM²	2.5 MM²	LIGHTING	ALL EMERGENCY AND EXIT		190		20MM
9			B3	10A	2.5 MM²	2.5 MM²	LIGHTING	ROOM			144	20MM
10			R4	16A	4 MM²	4 MM²	SOCKET	TRANSFORMER ROOM FOR PV + ELECTRICAL ROOM	900			25MM
11			Y4	16A	4 MM²	4 MM²	SOCKET	TRANSFORMER ROOM		540		25MM
12			B4	16A	4 MM²	4 MM²	SOCKET	CONTROL ROOM+TOILET			720	25MM
13			R5	16A	4 MM²		FAN	CONTROL PANEL FOR FANS	370			25MM
14			Y5	16A			FAN			370		25MM
15			B5	16A			FAN				370	25MM
16			R6	16A			SPARE					
17			Y6	16A			SPARE					

CONNECTED LOAD PHASE "R" =	***1534 W***	TOTAL CONNECTED LOAD (KW) =	***4.6***	TOTAL CONNECTED CURRENT "I"	***8.69***		LTG.	S.O	HVAC	KIT. EQP	EWH	TOTAL
CONNECTED LOAD PHASE "Y" =	***1460 W***	DEMAND FACTOR =	***78%***	TOTAL DEMAND CURRENT "I"	***6.80***	CONN.KW	1.31	2.16	1.11	0.00	0.00	4.58
CONNECTED LOAD PHASE "B" =	***1581 W***	TOTAL DEMAND LOAD (KW) =	***3.6***	TOTAL DEMAND CURRENT "I"	***7.48***	DEM.FACT	90.0%	60.0%	100.0%	80.0%	100.0%	78.3%
TOTAL CONNECTED LOAD =	***4575 W***	TOTAL DEMAND LOAD (KW) =	***3.9***	WITH 10% SPARE		DEM.KW	1.17	1.30	1.11	0.00	0.00	3.58
BALANCE : 7.65%		WITH 10% SPARE										



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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

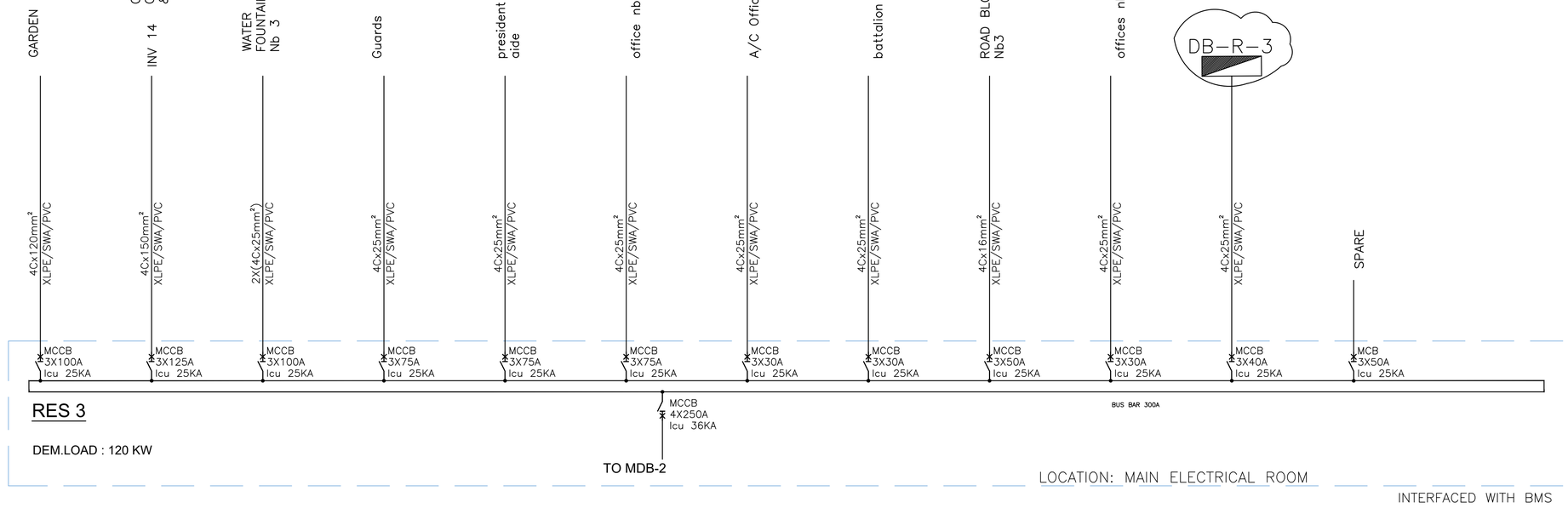
LEGEND
1 – ———————————
2 – ———————————
3 – ———————————
4 – ———————————
5 – ———————————
6 – ———————————

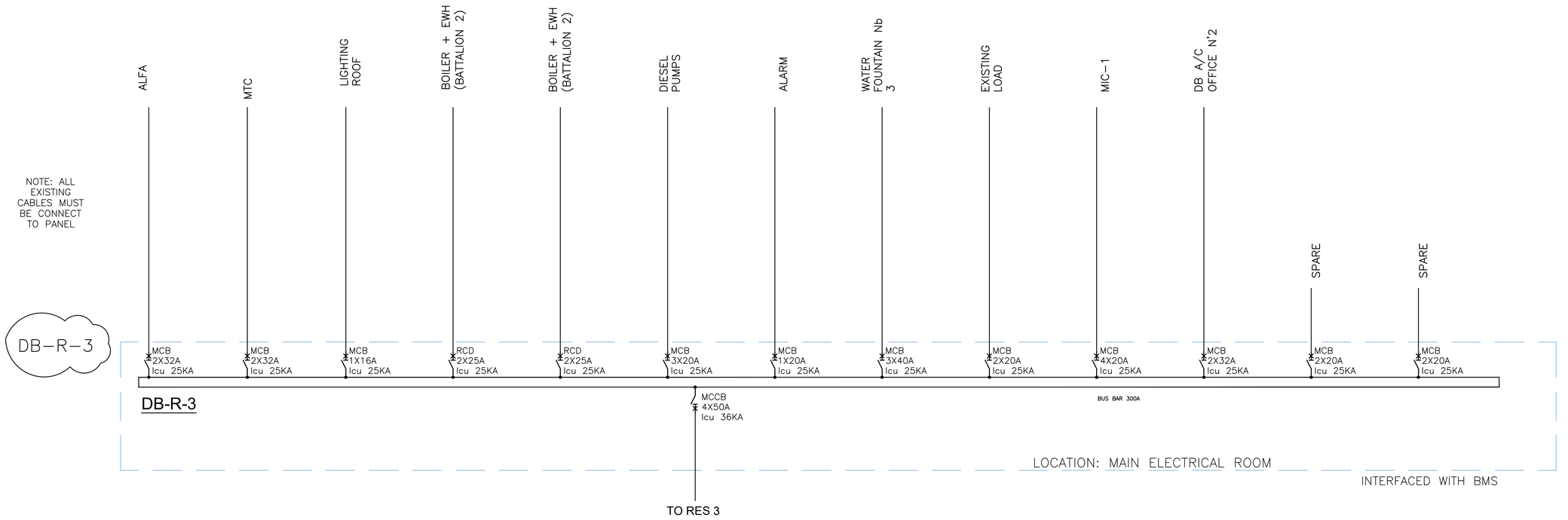
NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW PANEL BOARD 1/3

SCALE:	A1 – NO SCL
DATE:	OCT–2026
DRAWN:	M.H
CHECKED:	A.S
APP'D:	A.M
PROJ. No.:	DWG. No.:
L2026–14	E–406R1
APP'D FOR CONSTRUCTION :	
COMPUTER CODE No.	XX–AXXX





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NOTES
1 – XXXX
2 – XXXX
3 – XXXX
4 – XXXX
5 – XXXX
6 – XXXX

LEGEND
1 –
2 –
3 –
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5 –
6 –

REVISIONS	No.	BY	DATE
1 – XXXX	Rev1	X.X	X/XX/XX
2 – XXXX	Rev2	X.X	X/XX/XX
3 – XXXX	Rev3	X.X	X/XX/XX
4 – XXXX	Rev4	X.X	X/XX/XX
5 – XXXX	Rev5	X.X	X/XX/XX
6 – XXXX	Rev6	X.X	X/XX/XX

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PRESIDENTIAL PALACE

GENERAL DIRECTORATE BAABDA, LEBANON

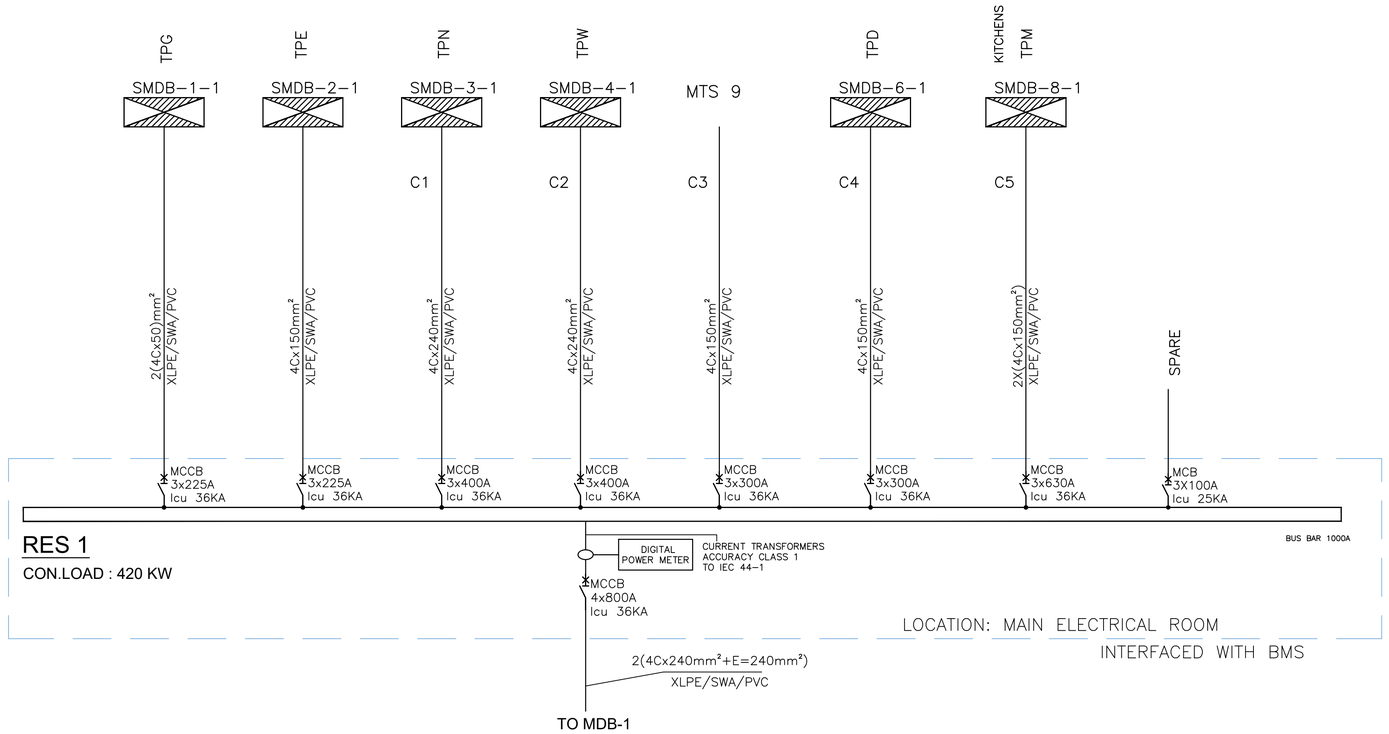
MAIN ELECTRICAL / GENERATOR ROOMS

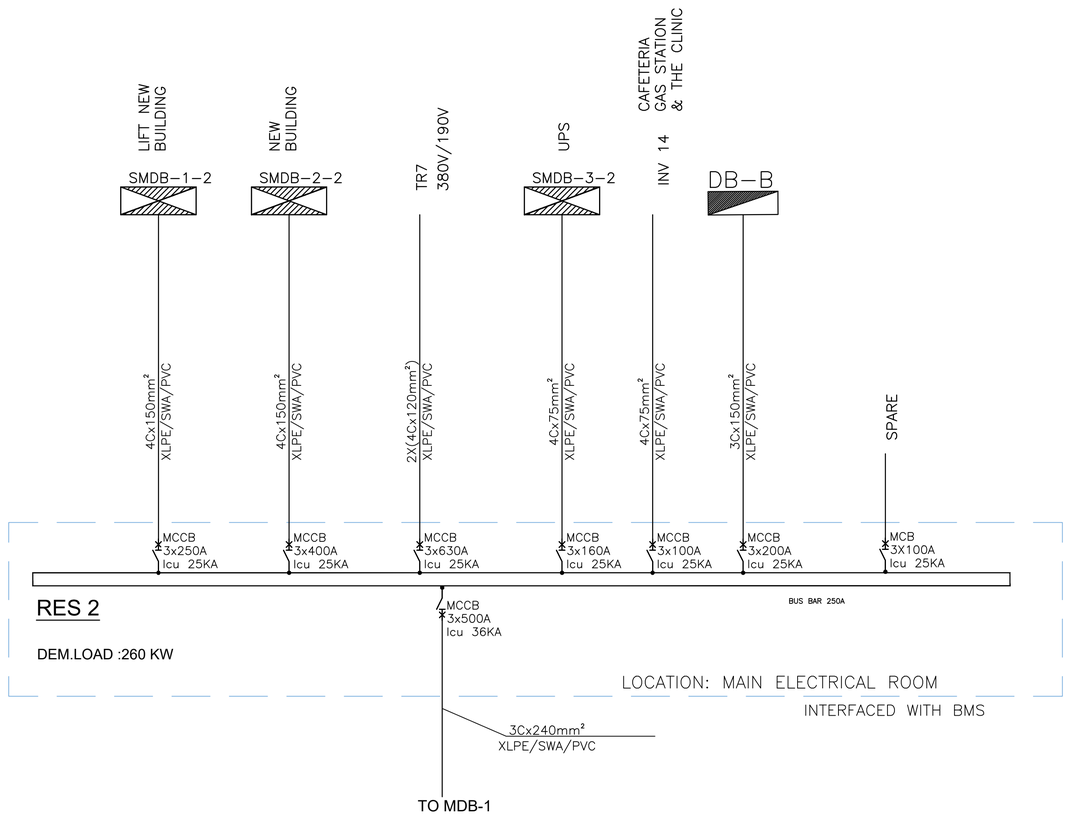
NEW PANEL BOARD 2/3

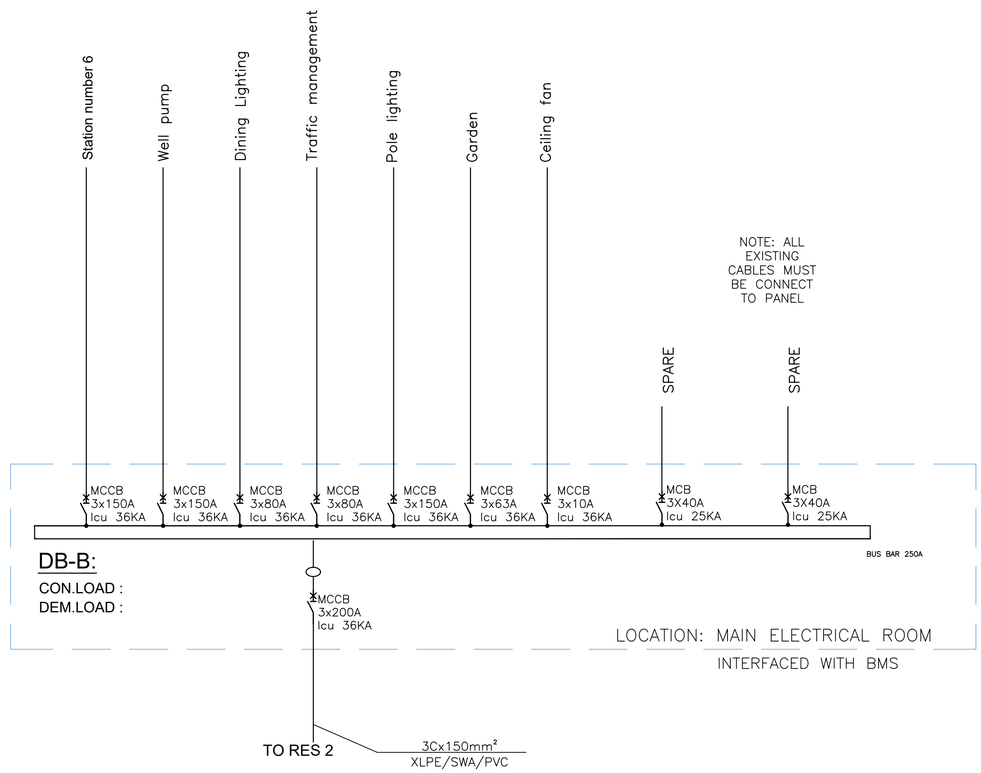
SCALE:	A1 – NO SCL
DATE:	OCT-2026
DRAWN:	M.H
CHECKED:	A.S
APP'D:	A.M
PROJ. No.:	DWG. No.:
L2026-14	E-407R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. | XX-AXXX







NOTES
1 – XXXX
2 – XXXX
3 – XXXX
4 – XXXX
5 – XXXX
6 – XXXX

LEGEND
1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
NEW PANEL BOARD 3/3

SCALE:	A1 – NO SCL
DATE:	OCT–2026
DRAWN:	M.H
CHECKED:	A.S
APP'D:	A.M
PROJ. No.:	DWG. No.:
L2026–14	E–408R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. | XX–AXXX

PHASE 2

FUEL

FUEL

G3

G4

IN1=2.25
TOP2=4.35

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM
FOR PV PANELS
01 GF

MV SWITCHGEAR

DB-GS

A1
A2

F4 MCCB 1500A TR1
F1 MCCB 1500A TR2
MCCB 1250A TR4

Medium voltage
from EDL 11kv

R4

SUPPLY
R4

VOID

CONTACTOR
C3–C4

G3
RES 3
CHILLER
G4
RES 2
RES 1
TR4

SUPPLY R2
SUPPLY R2

CONTACTOR
C5–C6

R3

BMS SMP

SOLAR MONITORING PANEL

Building Management System)

48-inch display screen

ATS–2
4X1250A

ATS–3
4X1250A

TOTALIZING PANEL–1
EDL OR GEN/SOLAR

MDB–1& MDB–2 +
BUS COUPLER 4X1600A

ELECTRICAL ROOM
02 GF

11KV/190V
TR–1
500KVA
MANUAL
VOLT
ADJUSTER

11KV/190V
TR–2
500KVA
MANUAL
VOLT
ADJUSTER

MDB FOR TR1 and
TR2

TR–5

ATS
SUPPLY
R2

ATS
SUPPLY
FOR
CHILLER

CHILLER

CONTACTOR
+DELAIS FOR R1

R1

MTS

CABINET
FOR
TR–1

TR–7

TR–AC

TR–8

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

LEGEND

1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

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No.	REVISIONS	BY	DATE
Rev1	1 – XXXXX	X.X	X/XX/XX
Rev2	2 – XXXXX	X.X	X/XX/XX
Rev3	3 – XXXXX	X.X	X/XX/XX
Rev4	4 – XXXXX	X.X	X/XX/XX
Rev5	5 – XXXXX	X.X	X/XX/XX
Rev6	6 – XXXXX	X.X	X/XX/XX

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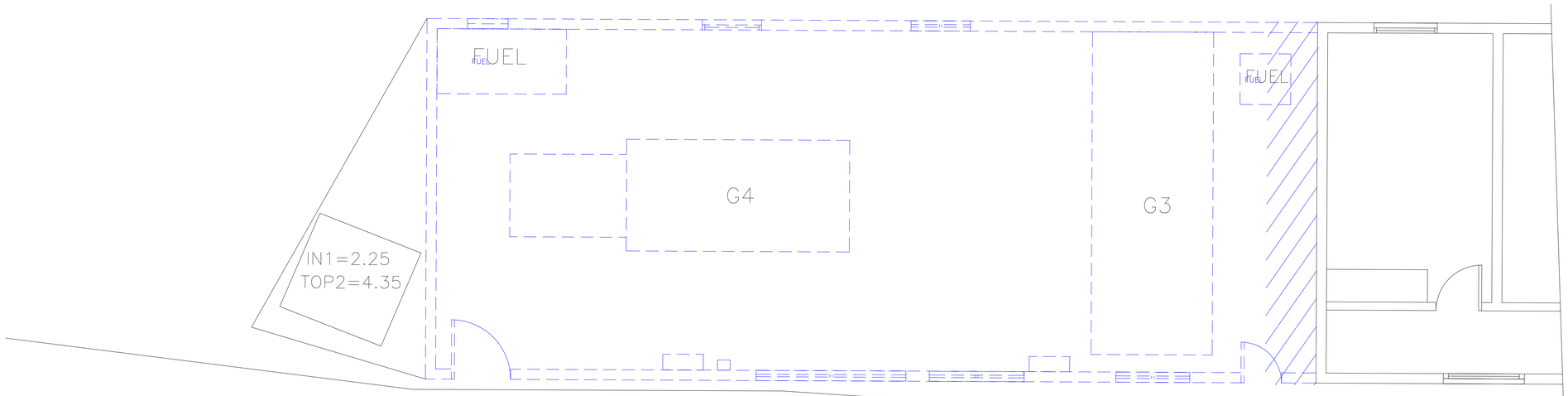
PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM–TRANSFORMER EXISTING LAYOUT

SCALE:	1/50
DATE:	OCT–2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
REVISION No.:	6 5 4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026–14	E–410R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A110

PHASE 2



Work Strategy - Generator Room

1- Dismantling and removing the existing 2 generators G3 & G4 600KVA , 725KVA. During the renovation period, G3 should be reinstalled temporary and connected to the load to maintain continuity of service and complete operational functionality including all temporary works required.

2- After completing civil works in generator room, Reinstall the existing generator G4 725KVA, Remove and handle G3 to the representative of the presidential palace.

3- Installation for the 3 new generators 500kVA with all equipment and accessories..

Work Strategy - MV Room

1- Renovate the existing MV room while maintaining continuity of power supply from the existing solar source and temporary generator G3.

2- Disconnect the MV source feed from EDL for safety precautions and connect a temporary source for MV Output JAPAN, coordinate with EDL.

3- Dismantling and removing the existing 2 old transformer 1&2 11KV/190V, 500KVA, and handle to the representative of the presidential palace.

4- Replace MV switchgear, cable routes, supports, lighting, ventilation, and room finishes.
Complete testing and commissioning before transferring the load to the renovated installation.

5- Install the new transformer 11kV/380V, 1600kVA with all equipment and accessories.



NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

LEGEND
1 –
2 –
3 –
4 –
5 –
6 –

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM-TRANSFORMER DEMOLISHING LAYOUT

SCALE:	1/50
DATE:	OCT-2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
REVISION No.:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026-14	E-411R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A111

PHASE 2

IN1=2.25
TOP2=4.35

FUEL

GEN-1 500KVA

GEN-2 500KVA

GEN-3 500KVA

EXISTING GEN/G4

GENERATOR ROOM
04 GF

TRENCH

DB-GS

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM
FOR PV PANELS
01 GF

MV SWITCHGEAR

ATS-2
4X1250A

ATS-3
4X1250A

TOTALIZING PANEL-1
EDL OR GEN/SOLAR

MDB-1& MDB-2 +
BUS COUPLER 4X1600A

R-1
PANEL

R-2
PANEL

R-3
PANEL

R-4
PANEL

ELECTRICAL ROOM
02 GF

TOTALIZING
PANEL-2 FOR
NEW GEN. SETS

ACB 2500A
NEW TR

ATS.1 2500A
EDL.1/EDL.2

TR-4

11KV/380V
1000KVA

Medium voltage
from EDL 11kv

JUNCTION
BOX R4

R4

TRANSFORMER ROOM
03 GF

Monitoring
and Alarm
Panel

NEW XER 1600KVA
11/0.38KV

JUNCTION
BOX R3

DB-R-3

DB-B

BMS SMP

SOLAR MONITORING PANEL

Building Management System)

48-inch display screen

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND

1 – ——————————
2 – ——————————
3 – ——————————
4 – ——————————
5 – ——————————
6 – ——————————

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM–TRANSFORMER PROPOSAL LAYOUT

SCALE:	1/50
DATE:	OCT–2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
DRAWING No.:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026–14	E–412R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A1T2

PHASE 2

IN1=2.25
TOP2=4.35

FUEL

GEN-1 500KVA

GEN-2 500KVA

GEN-3 500KVA

EXISTING GEN/G4

GENERATOR ROOM
04 GF

TRENCH

EXISTING 3X70mmsq 11KV CABLE FROM SOLAR XER WITH FOC FOR CONTROL

(3X6"PVC CONDUITS) FOR 11KV & F.O CABLES FROM SOLAR SYSTEM AT 60CM FROM FFL (ROAD CROSSING) PROTECTED BY CONCRETE ENCASEMENT

NEW TRENCH

6(4CX240mmsq) CABLES FROM NEW GEN.SETS TO TOTALIZING PANEL +3(4CX240mmsq FROM G4

(2X6X6"PVC CONDUITS) FOR CABLES FROM NEW GEN.SETS AT -60CM FROM FFL (ROAD CROSSING) PROTECTED BY CONCRETE ENCASEMENT

ELECTRICAL MAINHOLE 80X100CM FOR 11KV CABLE

ELECTRICAL MAINHOLE 140X100CM FOR LOW VOLTAGE CABLES

DB-GS

EXISTING 60X60 CM CHANNEL WITH GALVANIZED STEEL COVER FOR 11 KV CABLE 3(1X70mmsq)

EXISTING 60X60 CM CHANNEL WITH STEEL COVER FOR MV SWITCHGEAR

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM FOR PV PANELS
01 GF

The location for this channel must be as per the transformer outgoing cables

80X60 CM CHANNEL WITH GALVANIZED STEEL COVER FOR LOW VOLTAGE CABLES

EXISTING TRENCH

MCCB 1250A TR4

ATS-2 4X1250A

ATS-3 4X1250A

TOTALIZING PANEL-1 EDL OR GEN/SOLAR

MDB-1& MDB-2+ BUS COUPLER 4X1600A

80X60 CM CHANNEL FOR LOW VOLTAGE CABLES

TOTALIZING PANEL-2 FOR NEW GEN. SETS

ATS.1 2500A EDL:1/EDL.2

ATS.1 2500A EDL/GEN

ACB 2500A NEW TR

NEW TRENCH

ELECTRICAL ROOM
02 GF

EXISTING 80X60 CM CHANNEL WITH GALVANIZED STEEL COVER FOR LOW VOLTAGE CABLES 6(4CX240mmsq)

R-1 PANEL

R-2 PANEL

R-3 PANEL

R-4 PANEL

TR-4

11KV/380V
1000KVA

Medium voltage from EDL 11kv

JUNCTION BOX R4

R4

TRANSFORMER ROOM
03 GF

Monitoring and Alarm Panel

JUNCTION BOX R3

DB-R-3

NEW XER 1600KVA
11/0.38KV

BMS S.M.P

SOLAR MONITORING PANEL

Building Management System)

48-inch display screen

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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LEGEND

1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
ELECTRICAL TRENCH LAYOUT

SCALE:	1/50
DATE:	OCT-2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
DRG. SIZE:	A1
PROJ. No.:	DWG. No.:
L2026-14	E-413R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A112

TO DB-G/Y1

TO DB-G/B1

GEN-1 500KVA

GEN-2 500KVA

GEN-3 500KVA

EXISTING GEN/G4

IN1=2.25
TOP2=4.35

FUEL

DB-G

EXIT

GENERATOR ROOM
04 GF

EXIT

ALL EMERGENCY
AND EXIT TO DB-G/B2

TRENCH

TO DB-G/Y2

TO DB-GS/R3

DB-GS

EXISTING DB

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM
FOR PV PANELS
01 GF

MV SWITCHGEAR

ATS-2
4X1250A

ATS-3
4X1250A

TOTALIZING PANEL-1
EDL OR GEN/SOLAR

MDB-1& MDB-2 +
BUS COUPLER 4X1600A

R-1
PANEL

R-2
PANEL

R-3
PANEL

R-4
PANEL

ELECTRICAL ROOM
02 GF

TOTALIZING
PANEL-2 FOR
NEW GEN. SETS

ATS.1 2500A
EDL.1/EDL.2

ACB 2500A
NEW TR

TR-4

11KV/380V
1000KVA

Medium voltage
from EDL 11kv

TO DB-GS/Y2

TRANSFORMER ROOM
03 GF

NEW XER 1600KVA
11/0.38KV

JUNCTION
BOX R4

R4

TO DB-GS/B2

Monitoring
and Alarm
Panel

ALL EMERGENCY AND
EXIT TO DB-GS/Y3

JUNCTION
BOX R3

DB-R-3

D1

EXIT

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND

1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM-TRANSFORMER LGT LAYOUT

SCALE:	1/50
DATE:	OCT-2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
SHEET SIZE:	A1
PROJ. No.:	DWG. No.:
L2026-14	E-414R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A1T2

IN1=2.25
TOP2=4.35

FUEL

DB-G

GEN-1
500KVA

GEN-2
500KVA

GEN-3
500KVA

EXISTING GEN/G4

TO DB-G/RYB3

TO DB-G/R4

GENERATOR ROOM
04 GF

TRENCH

PROVISION FOR
A/C

2X16A
TO DB-GS/R6

DB-GS
EXISTING DB

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM
FOR PV PANELS
01 GF

MV SWITCHGEAR

ATS-2
4X1250A

ATS-3
4X1250A

TOTALIZING PANEL-1
EDL OR GEN/SOLAR

MDB-1& MDB-2 +
BUS COUPLER 4X1600A

R-1
PANEL

R-2
PANEL

R-3
PANEL

R-4
PANEL

ELECTRICAL ROOM
02 GF

TOTALIZING
PANEL-2 FOR
NEW GEN. SETS

ATS.1 2500A
EDL.1/EDL.2

ACB 2500A
NEW TR

TR-4

11KV/380V
1000KVA

Medium voltage
from EDL 11kv

JUNCTION
BOX R4

R4

TRANSFORMER ROOM
03 GF

TO DB-GS/Y4

Monitoring
and Alarm
Panel

TO DB-GS/R4

NEW XER 1600KVA
11/0.38KV

JUNCTION
BOX R3

PROVISION FOR
W.H.

2X16A
TO DB-GS/Y6

DB-R-3

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REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND

1 –
2 –
3 –
4 –
5 –
6 –

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

SPECTRUM ENGINEERING CONSULTANTS s.a.r.l.
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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM-TRANSFORMER PWR LAYOUT

SCALE:	1/50
DATE:	OCT-2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
DRAWING No.:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026-14	E-415R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A1T2

IN1=2.25
TOP2=4.35

FUEL

GEN-1
500KVA

GEN-2
500KVA

GEN-3
500KVA

EXISTING GEN/G4

GENERATOR ROOM
04 GF

TRENCH

DB-GS

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM
FOR PV PANELS
01 GF

MV SWITCHGEAR

ATS-2
4X1250A

ATS-3
4X1250A

TOTALIZING PANEL-1
EDL OR GEN/SOLAR

MDB-1& MDB-2 +
BUS COUPLER 4X1600A

R-1
PANEL

R-2
PANEL

R-3
PANEL

R-4
PANEL

ELECTRICAL ROOM
02 GF

TOTALIZING
PANEL-2 FOR
NEW GEN. SETS

ATS.1 2500A
EDL.1/EDL.2

ACB 2500A
NEW TR

TR-4

11KV/380V
1000KVA

Medium voltage
from EDL 11kv

TRANSFORMER ROOM
03 GF

NEW XER 1600KVA
11/0.38KV

DATA RACK

TV

JUNCTION
BOX R4

R4

Monitoring
and Alarm
Panel

JUNCTION
BOX R3

DB-R-3

BMS S.M.P

SOLAR MONITORING PANEL

Building Management System)

48-inch display screen

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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LEGEND

1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

REVISIONS	No.	BY	DATE
1 – XXXXX	Rev1	X.X	X/XX/XX
2 – XXXXX	Rev2	X.X	X/XX/XX
3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM-TRANSFORMER LWC LAYOUT

SCALE:	1/50
DATE:	OCT-2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
DRAWING No.:	4 3 2 1 0
PROJ. No.:	DWG. No.:
L2026-14	E-416R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A1T2

IN1=2.25
TOP2=4.35

CONTROL MODULE INTERFACE WITH –GENERATOR SOLENOID VALVE
–MOTORIZE FIRE DAMPERS
–CONTROL PANEL TO FIRE SUPPRESSION SYSTEM FOR GENERATOR ROOM

GEN-1 500KVA

GEN-2 500KVA

GEN-3 500KVA

EXISTING GEN/G4

INTERFACE WITH FLASH LIGHT

GENERATOR ROOM
04 GF

TRENCH

CONTROL MODULE INTERFACE WITH
–MOTORIZE FIRE DAMPERS
–CONTROL PANEL TO FIRE SUPPRESSION SYSTEM FOR ELECTRICAL ROOM

CONTROL MODULE INTERFACE WITH
–MOTORIZE FIRE DAMPERS
–CONTROL PANEL TO FIRE SUPPRESSION SYSTEM FOR EDL TRANSFORMER ROOM

CONTROL MODULE INTERFACE WITH
–MOTORIZE FIRE DAMPERS
–CONTROL PANEL TO FIRE SUPPRESSION SYSTEM FOR SOLAR TRANSFORMER ROOM

INTERFACE WITH FAN CONTROL PANEL CP–01

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM FOR PV PANELS
01 GF

MV SWITCHGEAR

ATS–2 4X1250A

ATS–3 4X1250A

TOTALIZING PANEL–1 EDL OR GEN/SOLAR

MDB–1& MDB–2 + BUS COUPLER 4X1600A

R–1 PANEL

R–2 PANEL

R–3 PANEL

R–4 PANEL

ELECTRICAL ROOM
02 GF

TOTALIZING PANEL–2 FOR NEW GEN. SETS

ACB 2500A NEW TR

MTS.1 2500AATS.1 2500A EDL.1/EDL.2 EDL/GEN

TR–4

11KV/380V
1000KVA

Medium voltage from EDL 11kv

JUNCTION BOX R4

R4

TRANSFORMER ROOM
03 GF

Monitoring and Alarm Panel

NEW XER 1600KVA
11/0.38KV

JUNCTION BOX R3

DB–R–3

NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

LEGEND
1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

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6 – XXXXX	Rev6	X.X	X/XX/XX

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BAHRAIN – SUDAN – YEMEN – SUDAN – ALBANIA – ROMANIA

PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM–TRANSFORMER FIRE ALARM LAYOUT

SCALE:	1/50
DATE:	OCT–2026
DRAWN:	A.F
CHECKED:	M.H.
APPD:	A.SH
DRG. STAT.	A / 1 / 0
PROJ. No.:	DWG. No.:
L2026–14	E–417R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A117

EARTH ROD WITH TEST LINK
ø18mm WITH 1.5m LONG
LEVEL GROUND
(SEE Detail 3)

EARTHING FOR GENERATOR

IN1=2.25
TOP2=4.35

FUEL

LINK

GEN-1 500KVA

GEN-2 500KVA

GEN-3 500KVA

EXISTING GEN/G4

GENERATOR ROOM
04 GF

TRENCH

EARTHING FOR TRANSFORMER

EARTH ROD WITH TEST LINK
ø18mm WITH 1.5m LONG
LEVEL GROUND
(SEE Detail 3)

LINK

SOLAR XER 2MVA
11/0.4KV

TRANSFORMER ROOM
FOR PV PANELS
01 GF

MV SWITCHGEAR

ATS-2
4X1250A

ATS-3
4X1250A

TOTALIZING PANEL-1
EDL OR GEN/SOLAR

MDB-1& MDB-2 +
BUS COUPLER 4X1600A

R-1 PANEL

R-2 PANEL

R-3 PANEL

R-4 PANEL

ELECTRICAL ROOM
02 GF

TOTALIZING PANEL-2 FOR NEW GEN. SETS

ATS.1 2500A EDL.1/EDL.2

ACB 2500A NEW TR

TR-4

11KV/380V
1000KVA

Medium voltage from EDL 11kv

TRANSFORMER ROOM
03 GF

JUNCTION BOX R4

R4

Monitoring and Alarm Panel

NEW XER 1600KVA
11/0.38KV

JUNCTION BOX R3

DB-R-3

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3 – XXXXX	Rev3	X.X	X/XX/XX
4 – XXXXX	Rev4	X.X	X/XX/XX
5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

LEGEND
1 – ----------
2 – ----------
3 – ----------
4 – ----------
5 – ----------
6 – ----------

NOTES
1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

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PRESIDENTIAL PALACE
GENERAL DIRECTORATE BAABDA, LEBANON
MAIN ELECTRICAL / GENERATOR ROOMS
MAIN ELECTRICAL ROOM-TRANSFORMER EARTHING SYSTEM LAYOUT

SCALE:	1/50
DATE:	OCT-2026
DRAWN:	A.F
CHECKED:	M.H.
APP'D:	A.SH
SHEET SIZE No.:	A 3 2 1 0
PROJ. No.:	DWG. No.:
L2026-14	E-418R1

APP'D FOR CONSTRUCTION :

COMPUTER CODE No. L2026-14-A1T2

TRANSFORMER 2MVA - SOLAR

PANEL

- TRANSFORMER GENERAL ALARM
- TRANSFORMER HIGH TEMPERATURE ALARM
- TRANSFORMER BREAKER ON/OFF STATUS
- TRANSFORMER BREAKER TRIP STATUS

TRANSFORMER 1600KVA - EDL

PANEL

- TRANSFORMER GENERAL ALARM
- TRANSFORMER HIGH TEMPERATURE ALARM
- TRANSFORMER BREAKER ON/OFF STATUS
- TRANSFORMER BREAKER TRIP STATUS

TRANSFORMER 1000KVA - EDL

PANEL

- TRANSFORMER GENERAL ALARM
- TRANSFORMER HIGH TEMPERATURE ALARM
- TRANSFORMER BREAKER ON/OFF STATUS
- TRANSFORMER BREAKER TRIP STATUS

MV PANEL

PANEL

- MAIN INCOMER ON/OFF STATUS
- MAIN INCOMING TRIP STATUS
- OUTGOING-1 BREAKER ON/OFF STATUS
- OUTGOING-1 BREAKER TRIP STATUS
- OUTGOING-2 BREAKER ON/OFF STATUS
- OUTGOING-2 BREAKER TRIP STATUS

MDB-1 PANEL

PANEL

- MAIN INCOMER BREAKER ON/OFF STATUS
- MAIN INCOMING BREAKER TRIP STATUS
- OUTGOING-1 BREAKER ON/OFF STATUS
- OUTGOING-1 BREAKER TRIP STATUS
- OUTGOING-2 BREAKER ON/OFF STATUS
- OUTGOING-2 BREAKER TRIP STATUS
- OUTGOING-3 BREAKER ON/OFF STATUS
- OUTGOING-3 BREAKER TRIP STATUS
- MAIN INCOMER KW
- MAIN INCOMER VOLTAGE
- MAIN INCOMER LOADING CURRENT AMPS
- MAIN INCOMER FREQUENCY

MDB-2 PANEL

PANEL

- MAIN INCOMER BREAKER ON/OFF STATUS
- MAIN INCOMING BREAKER TRIP STATUS
- OUTGOING-1 BREAKER ON/OFF STATUS
- OUTGOING-1 BREAKER TRIP STATUS
- OUTGOING-2 BREAKER ON/OFF STATUS
- OUTGOING-2 BREAKER TRIP STATUS
- OUTGOING-3 BREAKER ON/OFF STATUS
- OUTGOING-3 BREAKER TRIP STATUS
- OUTGOING-4 BREAKER ON/OFF STATUS
- OUTGOING-4 BREAKER TRIP STATUS
- MAIN INCOMER KW
- MAIN INCOMER VOLTAGE
- MAIN INCOMER LOADING CURRENT AMPS
- MAIN INCOMER FREQUENCY

3(500 KVA) GENERATORS TOTALIZING PANEL

PANEL

- MAIN INCOMER G-1 ON/OFF STATUS
- MAIN INCOMER G-1 TRIP STATUS
- MAIN INCOMER G-2 ON/OFF STATUS
- MAIN INCOMER G-2 TRIP STATUS
- MAIN INCOMER G-3 ON/OFF STATUS
- MAIN INCOMER G-3 TRIP STATUS
- OUTGOING BREAKER ON/OFF STATUS
- OUTGOING BREAKER TRIP STATUS
- OUTGOING KW
- OUTGOING VOLTAGE
- OUTGOING LOADING CURRENT AMPS
- OUTGOING FREQUENCY

GEN.OR EDL WITH SOLAR TOTALIZING PANEL

PANEL

- MAIN INCOMER-1 GEN. OR EDL ON/OFF STATUS
- MAIN INCOMER-1 GEN. OR EDL TRIP STATUS
- MAIN INCOMER-2 SOLAR SYSTEM ON/OFF STATUS
- MAIN INCOMER-2 SOLAR SYSTEM TRIP STATUS
- OUTGOING BREAKER-1 TRIP STATUS
- OUTGOING BREAKER-1 ON/OFF STATUS
- OUTGOING BREAKER-2 ON/OFF STATUS
- OUTGOING BREAKER-2 TRIP STATUS
- OUTGOING BREAKER-3 ON/OFF STATUS
- OUTGOING BREAKER-3 TRIP STATUS
- MAIN INCOMER-1 GEN. OR EDL VOLTAGE
- MAIN INCOMER-1 GEN. OR EDL CURRENT AMPS
- MAIN INCOMER-1 GEN. OR EDL FREQUENCY
- MAIN INCOMER-2 SOLAR SYSTEM (KW)
- MAIN INCOMER-2 SOLAR SYSTEM VOLTAGE
- MAIN INCOMER-2 SOLAR SYSTEM LOADING CURRENT AMPS
- MAIN INCOMER-2 SOLAR SYSTEM FREQUENCY

RESEAU-1 PANEL

PANEL

- MAIN INCOMER BREAKER ON/OFF STATUS
- MAIN INCOMING BREAKER TRIP STATUS
- MAIN INCOMING BREAKER ON/OFF STATUS
- OUTGOING-1 BREAKERS TRIP STATUS
- MAIN INCOMER KW
- MAIN INCOMER VOLTAGE
- MAIN INCOMER LOADING CURRENT AMPS
- MAIN INCOMER FREQUENCY

RESEAU-2 PANEL

PANEL

- MAIN INCOMER BREAKER ON/OFF STATUS
- MAIN INCOMING BREAKER TRIP STATUS
- OUTGOING-1 BREAKERS ON/OFF STATUS
- OUTGOING-1 BREAKERS TRIP STATUS
- MAIN INCOMER KW
- MAIN INCOMER VOLTAGE
- MAIN INCOMER LOADING CURRENT AMPS
- MAIN INCOMER FREQUENCY

RESEAU-3 PANEL

PANEL

- MAIN INCOMER BREAKER ON/OFF STATUS
- MAIN INCOMING BREAKER TRIP STATUS
- OUTGOING-1 BREAKERS ON/OFF STATUS
- OUTGOING-1 BREAKERS TRIP STATUS
- MAIN INCOMER KW
- MAIN INCOMER VOLTAGE
- MAIN INCOMER LOADING CURRENT AMPS
- MAIN INCOMER FREQUENCY

RESEAU-4 PANEL

PANEL

- MAIN INCOMER BREAKER ON/OFF STATUS
- MAIN INCOMING BREAKER TRIP STATUS
- OUTGOING-1 BREAKERS ON/OFF STATUS
- OUTGOING-1 BREAKERS TRIP STATUS
- MAIN INCOMER KW
- MAIN INCOMER VOLTAGE
- MAIN INCOMER LOADING CURRENT AMPS
- MAIN INCOMER FREQUENCY

CHILLER PANEL

PANEL

- MAIN INCOMER BREAKER ON/OFF STATUS
- MAIN INCOMING BREAKER TRIP STATUS
- OUTGOING-1 BREAKERS ON/OFF STATUS
- OUTGOING-1 BREAKERS TRIP STATUS
- MAIN INCOMER KW
- MAIN INCOMER VOLTAGE
- MAIN INCOMER LOADING CURRENT AMPS
- MAIN INCOMER FREQUENCY

CCTV SYSTEM

CP

- CCTV SYSTEM ON/OFF STATUS
- CCTV SYSTEM GENERAL ALARM
- CCTV SYSTEM PANEL HEALTH STATUS

FIRE ALARM SYSTEM

FIRE ALARM SYSTEM

CP

- FIRE ALARM CONTROL PANEL ON/OFF STATUS
- FIRE ALARM CONTROL PANEL GENERAL ALARM
- FIRE ALARM CONTROL PANEL HEALTH STATUS

FIRE ALARM SYSTEM INTERFACE WITH BMS

INVERTERS SOLAR TOTALIZING PANEL

PANEL

- MAIN INCOMER- INV-1 ON/OFF STATUS
- MAIN INCOMER -INV-1 TRIP STATUS
- MAIN INCOMER- INV-2 ON/OFF STATUS
- MAIN INCOMER -INV-2 TRIP STATUS
- MAIN INCOMER- INV-3 ON/OFF STATUS
- MAIN INCOMER -INV-3 TRIP STATUS
- MAIN INCOMER- INV-4 ON/OFF STATUS
- MAIN INCOMER -INV-4 TRIP STATUS
- MAIN INCOMER- INV-5 ON/OFF STATUS
- MAIN INCOMER -INV-5 TRIP STATUS
- MAIN INCOMER-1 GEN. OR EDL (KW)
- OUTGOING BREAKER ON/OFF STATUS
- OUTGOING BREAKER TRIP STATUS
- OUTGOING KW
- OUTGOING VOLTAGE
- OUTGOING LOADING CURRENT AMPS
- OUTGOING FREQUENCY
- MAIN INCOMER- INV-1 KW
- MAIN INCOMER- INV-1 VOLTAGE
- MAIN INCOMER- INV-1 LOADING CURRENT AMPS
- MAIN INCOMER- INV-1 FREQUENCY
- MAIN INCOMER- INV-2 KW
- MAIN INCOMER- INV-2 VOLTAGE
- MAIN INCOMER- INV-2 LOADING CURRENT AMPS
- MAIN INCOMER- INV-2 FREQUENCY
- MAIN INCOMER- INV-3 KW
- MAIN INCOMER- INV-3 VOLTAGE
- MAIN INCOMER- INV-3 LOADING CURRENT AMPS
- MAIN INCOMER- INV-3 FREQUENCY
- MAIN INCOMER- INV-4 KW
- MAIN INCOMER- INV-4 LOADING CURRENT AMPS
- MAIN INCOMER- INV-4 FREQUENCY
- MAIN INCOMER- INV-5 KW
- MAIN INCOMER- INV-5 LOADING CURRENT AMPS
- MAIN INCOMER- INV-5 FREQUENCY

INVERTER-1

PANEL

- OUTGOING INV-1 BREAKERS ON/OFF STATUS
- OUTGOING INV-1 BREAKERS TRIP STATUS
- OUTGOING INV-1 KW
- OUTGOING INV-1 VOLTAGE
- OUTGOING INV-1 LOADING CURRENT AMPS
- OUTGOING INV-1 FREQUENCY
- INVERTER-1 FAULT

INVERTER-2

PANEL

- OUTGOING INV-2 BREAKERS ON/OFF STATUS
- OUTGOING INV-2 BREAKERS TRIP STATUS
- OUTGOING INV-2 KW
- OUTGOING INV-2 VOLTAGE
- OUTGOING INV-2 LOADING CURRENT AMPS
- OUTGOING INV-2 FREQUENCY
- INVERTER-2 FAULT

INVERTER-1

PANEL

- OUTGOING INV-3 BREAKERS ON/OFF STATUS
- OUTGOING INV-3 BREAKERS TRIP STATUS
- OUTGOING INV-3 KW
- OUTGOING INV-3 VOLTAGE
- OUTGOING INV-3 LOADING CURRENT AMPS
- OUTGOING INV-3 FREQUENCY
- INVERTER-3 FAULT

INVERTER-1

PANEL

- OUTGOING INV-1 BREAKERS ON/OFF STATUS
- OUTGOING INV-2 BREAKERS TRIP STATUS
- OUTGOING INV-1 KW
- OUTGOING INV-1 VOLTAGE
- OUTGOING INV-1 LOADING CURRENT AMPS
- OUTGOING INV-1 FREQUENCY
- INVERTER-4 FAULT

INVERTER-1

PANEL

- OUTGOING INV-1 BREAKERS ON/OFF STATUS
- OUTGOING INV-2 BREAKERS TRIP STATUS
- OUTGOING INV-1 KW
- OUTGOING INV-1 VOLTAGE
- OUTGOING INV-1 LOADING CURRENT AMPS
- OUTGOING INV-1 FREQUENCY
- INVERTER-5 FAULT

EXTRACT FAN-1

- FAN FLOW STATUS
- FAN AUTO/HAND STATUS
- FAN MOTOR START/STOP COMMAND
- FAN LO/HI MOTOR ON/OFF STATUS
- FAN LO/HI MOTOR TRIP/ALARM STATUS

MCC | FACP

- FIRE ALARM STATUS

EXTRACT FAN-2

- FAN FLOW STATUS
- FAN AUTO/HAND STATUS
- FAN MOTOR START/STOP COMMAND
- FAN LO/HI MOTOR ON/OFF STATUS
- FAN LO/HI MOTOR TRIP/ALARM STATUS

MCC | FACP

- FIRE ALARM STATUS

EXTRACT FAN-3

- FAN FLOW STATUS
- FAN AUTO/HAND STATUS
- FAN MOTOR START/STOP COMMAND
- FAN LO/HI MOTOR ON/OFF STATUS
- FAN LO/HI MOTOR TRIP/ALARM STATUS

MCC | FACP

- FIRE ALARM STATUS

DIESEL GENERATOR SET

DIESEL GENERATOR CONTROL PANEL

- DG ON/OFF STATUS
- DG MAIN BREAKER ON/OFF STATUS
- DG MAIN BREAKER TRIP ALARM
- DG GENERAL ALARM
- DG BATTERY HEALTHY STATUS
- ATS ON/OFF STATUS
- ATS TRIP ALARM
- OIL FUEL PUMP ON/OFF STATUS
- OIL FUEL PUMP TRIP ALARM
- OIL FUEL PUMP FILTER STATUS

FUEL CONTROL PANEL

- MAIN FUEL TANK LEVEL
- MAIN FUEL TANK LOW LEVEL STATUS
- MAIN FUEL TANK HI LEVEL STATUS
- DAILY FUEL TANK LOW LEVEL STATUS
- DAILY FUEL TANK HI LEVEL STATUS

GENERATOR ROOM TEMPERATURE SENSOR

FM 200

PANEL

- CONTROL PANEL ON/OFF STATUS
- CONTROL PANEL HEALTH STATUS

FM 200

PANEL

- CONTROL PANEL ON/OFF STATUS
- CONTROL PANEL HEALTH STATUS

NOTES

1 – XXXXX
2 – XXXXX
3 – XXXXX
4 – XXXXX
5 – XXXXX
6 – XXXXX

LEGEND

1 – ----------
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5 – XXXXX	Rev5	X.X	X/XX/XX
6 – XXXXX	Rev6	X.X	X/XX/XX

SPECTRUM ENGINEERING CONSULTANTS S.A.R.L.
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GENERAL DIRECTORATE BAABDA, LEBANON
SUSTAINABLE ENERGY "SOLAR PANELS"
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