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

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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.