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# ELECTRICAL WORKS

## PART 1 - GENERAL

*ELECTRICAL SUB-CONTRACTOR*

**A.** The electrical work shall be carried out by an electrical sub-contractor who is on the approved list of electrical contractor's.

**B.** The electrical sub-contractor must have, during the entire duration of the Contract, qualified electrical engineer and electrical supervisor for ensuring proper execution and supervision of work. The electrical engineer should be registered with the Local Engineer's Association and his name, qualifications and experience should be submitted for approval. The electrical engineer and supervisor should be available at site during all working hours.

**C.** The name of the electrical sub-contractor, details of his experience and his staff qualifications and experience shall be submitted by the tenderer with his tender in accordance with form shown hereinafter which shall be filled by the tenderer and his proposed sub-contractor.

### 1.01 SCOPE OF WORK

**A.** The Work included in these Specifications is for the complete Electrical Services for the Project. The Work described and included in this Specification is for the manufacture works, testing, supply, delivery to site, erection, connection, site testing, demonstrating, commissioning and maintaining for required duration, all equipment and installation as described in this Specifications and shown on Contract Drawings. Additionally all equipment and installation shall conform to local authorities Specifications.

Any Works whether or not shown on the Drawings and/or described in the Specifications but which can reasonably be inferred as necessary for the completion and proper operation of the works will also form part of the extent of the Contract

**B.** All Electrical Works complete in all respects shall be provided in accordance with the requirements of the Contract Documents. The scope of works shall include, but not be limited to the following:

## 1.02 A. RELATED SECTIONS

| SECTION | Title |
|---|---|
| 14200 | Conveiance System |
| 16000 | Electrical Works |
| 16010 | General Provisions for Electrical Work |
| **16110** | **Raceways** |
| 16120 | Conduits |
| 16200 | Cables and Wires |
| 16300 | Supporting Devices |
| 16400 | Main Distribution Equipment |
| 16500 | Lighting |
| 16640 | Earthing |
| 16670 | Lightning Protection system |
| **16720** | **Fire Detection and Alarm System** |
| 16760 | Data System |
| 16771 | Public Address /Evacuation System |
| **16772** | **Audio Visual, Conference, Interpretation System** |
| 16960 | Building Surveillance System (CCTV) |

## B. RELATED WORKS SPECIFIED ELSEWHERE

The following related service installations are specified in other divisions of the Specifications. The Contractor shall co-ordinate all his installation with the related works such as:

- Plumbing
- HVAC
- Fire Fighting
- Interior Finishes & Architectural Works
- Any other sub-contractor engaged for the project.

## 1.03 REGULATIONS

### A. Authorities and Regulations

The Contractor shall comply with all statutory requirements and regulations issued by the local authorities within whose area of jurisdiction the site is contained.

The Contractor shall also comply with the relevant "Codes of Practice" issued by the British Standards Institution and the latest edition of the "Regulations for the Electrical Equipment of Buildings" issued by the Institution of Electrical Engineers, and any supplements thereto.

## 1.04 CLIMATIC CONDITIONS

**A.** Extremes of temperature and humidity are experienced. Periods of high humidity has been recorded.

Sand and dust storms occur and even on comparatively still days, fine dust is carried in the atmosphere.

**B.** All equipment and materials forming the electrical installation work shall be designed and constructed to provide satisfactory service without any harmful effects for prolonged and continuous use in the climate of the project Generally, the following temperatures shall be made as design criteria:

1. 35 Deg. C if installed within buildings having good heat insulating properties and adequate ventilation.

2. 40 Deg.C if installed in well ventilated positions and shaded from direct sunlight throughout the day.

3. 45 Deg.C if exposed to direct sunlight.

**C.** ***Minimum Temperatures Likely to Occur are:***

1. -5 Deg.C outdoors.

2. 10 Deg.C indoor.

**D.** The above temperatures do not take into consideration heat generated from the equipment itself or from any other equipment installed in the vicinity.

**E.** The capacity and rating of all electrical equipment and materials given are Local rating, i.e. rating when equipment are operating under Local Climatic Conditions. Any derating factors applied should be clearly indicated.

**F.** Where specific sizes are indicated e.g. cable sizes, due allowances have been made in the design for the climatic conditions of project and de-rating has been applied.

## 1.05 ELECTRICITY SUPPLY

**A.** All electrical equipment accessories and fittings shall be designed and manufactured to operate continuously in the electricity supply system having the following characteristics: -

| | |
|---|---|
| Voltage | 415 Volts ± 6% 3Phase 4-Wire |
| Frequency | 50 Hz ± 4% |
| Neutral | Solidly Earthed |
| Fault Level | 31 MVA at 415 volts |
| Fault Duration | 0.5 Seconds |

## 1.06 STANDARDS

**A.** All works contained herein shall be subject in every respect to the approval of the Engineer.

The design manufacture installation and testing of all materials and equipment shall comply with the latest Local Authorities Specifications. Where no particular item is not specified by Local Authorities Specifications, relevant recommendation of the International Electrotechnical Commission (I.E.C.) and if this is not available then with the latest relevant British Standard Specification (B.S.S.) or other approved National Standards. Specifically the following standards/regulations/codes shall be acceptable:

- IES/CIBSE Illumination codes
- CIE International Commission on Illumination
- Relevant British Standard Codes for Practice (BSCP)
- International Commission for Conformity Certification of Electrical Equipment (CEE)
- Specifications for Installation of Telephones, issued by the Ministry Of Telecommunication.
- The latest relevant recommendations of the committee 'Consultant International Telephone and Telegraph (CCITT)
- Civil Defense Fire Department
- British Fire Officer's Committee (FOC) Rules (Latest Edition)

- National Fire Protection Association (NFPA)

**B.** Standards for materials and the design of equipment are quoted throughout this specification and the Contractor shall produce copies of these Standards as required and instructed by the Engineer. If the Contractor offers equipment, which is not manufactured, in compliance with these Standards the equipment offered should be at least equal in performance and quality to that required by the relevant Standard.

**C.** In the event of the Contractor offering materials or equipment which differs from that described in this Specification, the Contractor shall include for all the costs involved in checking the design, any necessary redesign, drawings and the modifications to other equipment of the affected system.

**D.** While making an offer, the Tenderer should specify the name of the Manufacturer he intends to use for the supply of each equipment material/light fitting etc. In offering such material or equipment or light fitting he shall include with his tender the detailed information necessary to demonstrate quality. The presentation of such data shall take the form of a comparison sheet giving on one column the critical parameters required by the relevant Standard and/or equipment specified and an adjacent column giving the standards of the equipment offered in the Tender. Where manufacturers names are particularly specified for any item, the contractor must choose from the specified manufacturer(s).

**E.** The term "materials" as used in this Specification refers to any basic engineering equipment which forms part of the installation but which in itself does not form a unit which can be specified with an output performance.

**F.** Materials are related to a Standard whenever applicable and it is deemed that such reference, without further amplification, includes the whole of the current Standard. With the approval of the Engineer, alternative and equivalent National or International Standards may be used, but these must be declared and agreed at the time of Tendering.

**G.** All materials/equipments/light fittings manufacturers selected by the contractor shall have established local agents.

## 1.07 CAPACITIES AND DERATING FACTORS

The capacities and ratings of the equipment, electrical components and accessories shall be sufficient to give satisfactory service in the environments conditions stated herein before.

Sizes of electrical cables and wires shall be determined by suitably derating the current ratings of such cables and wires in accordance with the rating factors indicated in the I.E.E. Regulations. The attention of the Contractor is drawn to the fact that the application of derating factors for the higher ambient temperatures will not by itself

render the equipment suitable for the climatic conditions of the site. Full considerations shall be given to the severe climatic conditions.

## 1.08 FUSING AND PROTECTION

**A.** The rating (in amperes) of circuit breakers, switch fuses and circuit ways of distribution boards given on diagrams or drawings are the maximum normal (operating) rating permissible for such circuit.

On completion of the installation it shall be the responsibility of the Contractor to set the overload protection appropriate to the actual loading on each circuit.

The Contractor shall be held liable to make good any damage resulting from overloading should it be discovered that overloads where improperly set or fused incorrectly rated.

Under no circumstances shall cartridge fuse carriers be bridged with loose fuse wire. In the event of such malpractice being discovered, the Contractor will be required to replace the whole assembly if such a fuse is blown.

## 1.09 RADIO INTERFERENCE SUPPRESSION

**A.** All electrical equipment shall be provided with suitable means of suppressing radio frequency interference fully in accordance with various requirements stipulated in relevant British Standards.

## 1.10 DIMENSIONS OF EQUIPMENT

**A.** The Contractor shall ensure that all plant and equipment included in his offer can be accommodated in the position shown on the drawings without structural alterations. The Engineer will not consider any claims for additional payments resulting from modifications arising from equipment of unsuitable dimensions being provided.

## 1.11 DRAWINGS

**A.** Before signing the contract, the Contractor should obtain a set of the approved drawings by the local authorities. It shall deemed to be understood that Contractor has taken into account the difference between Tender Document/Drawings and the approved drawings and that he shall not be eligible for any additional payments/variations etc.

**B.** Refer to all other Architectural, Structural and Mechanical Drawings to verify all spaces and conditions affecting the electrical work and to ascertain the location and routes of all gas and water services, AC ducts, piping ...etc. so as to maintain adequate clearance between electrical and other services. The Drawings shall be available at the main contractor's Office. In case of discrepancy the decision of the engineer shall be final.

**C.** ***Shop Drawings***

1. Prepare and submit for approval, before commencing any portion of the Contract work, complete shop drawings, which shall show:

   - Exact routes of cables and ducts including sizes and details of installation.

   - Cable trays and ladders giving routes, sizes and details of supports and hangers.

   - Exact runs of conduits and trunking including sizes, draw boxes and junction boxes and the number and sizes of wires in each run.

   - Switch boards and distribution boards and control panels including location, layout, dimensions, fixing details, cabling and final connection arrangement.

   - Proposed supports and hangers for cable trays, trunking, conduits, cables, light fittings ...etc. including details of materials, finish, sizes and method of fixing to structure.

   - The contractor shall submit sections and elevations as required by the Engineer to show details of installation showing plant, equipment, fixtures in true dimensions in relation to furniture and other elements in the concerned area.

**2.** Shop drawings shall be made to a scale not less than 1/100 or as required by the Engineer. A detailed duly updated record shall be kept by the Contractor of all service distribution routes and installation work during the Contract duly titled.

**3.** The shop drawings shall be coordinated with the work of all other Trades and shall where necessary show adjacent services to indicate satisfactory coordination. Where necessary or when requested by the Engineer, provide coordinated sections to a suitable scale to suit each condition. Drawings of other Trades which are not forming part of this Contract if required for coordination purposes will be issued to the Contractor by the Engineer.

## D. ***Progress Drawings***

1. Furnish and keep on the job site at all times, one complete and separate set of blackline prints of the Electrical Work on which shall be clearly, neatly and accurately noted, promptly as the work progress, all electrical changes, revisions and additions to work as actually installed. Wherever work is installed other than as shown on the drawings, such changes shall be noted.

2. Indicate daily progress on progress prints by colouring in the various parts of the Works as they are erected.

**E.** ***Record Drawings / As Built Drawings***

1. At the conclusion of work, prepare and submit "Record Drawings" (As Built Drawings)..

2. These drawings shall be titled "Record Drawings" and shall be prepared from the marked up progress prints. Submit "Record Drawings" to the Engineer for review and approval.

3. Should there be any difference between the final "Record Drawings" and the Contract Drawings, then arrange for obtaining approval of the final "Record Drawings" from the local authorities.

4. The Contractor shall submit "As Built Drawings" as under:

   a) 3 sets of computer compact disk (CD) prepared on AutoCAD.

   b) 5 sets of paper prints of the "As Built Drawings" each set in binder form.

**F.** ***Approval from Authorities***

The contractor shall be responsible for obtaining design and as built approvals from all local authorities, Civil Defense Fire department, etc. in respect of the following:

1. All works executed by him including any extension works added during construction.

2. Any changes made on the design during construction.

3. Any alterations, modifications made during construction.

4. Any other approvals specifically asked for in this document or B.O.Q.

## 1.12 DISCREPANCIES

**A.** Before signing the contract, the Contractor should verify for himself any discrepancies between B.O.Q and the drawings. He may add in his offer any additional amounts that are required to meet the discrepancies. Under No circumstances he will be eligible for additional claims on account of such discrepancies

*PART 2 – PRODUCT*

## 2.01 MATERIALS

**A.** All equipment and materials used in the electrical installation work shall be new and of the highest quality. They shall be suitable for operation the standard voltage and frequency in the area of the project.

**B.** Unless otherwise specified, all equipment and materials shall comply as a minimum with the latest relevant recommendations of the International Electrotechnical Commission (IEC). If these are not available for any equipment or material then the latest relevant British Standard shall be followed.

**C.** If standards mentioned above contradict with this Specification, then the requirements of this Specification shall prevail.

**D.** Electrical equipment and material complying with other national standards may be considered for use in the work provided, the Contractor shall, at the time of submitting his offer, confirm in writing that such standards meet the requirements of IEC/BSS as regards characteristics, requirements and testing procedures as a minimum. The Contractor, if awarded the work on the basis, shall be required to substantiate this by producing all relevant data and test certificates and, if needed, by report from an approved inspecting and testing authority confirming that the results of the tests carried out on these equipment and materials meet the requirements of IEC/BSS as a minimum. Only after the production of such evidence and subsequent approval of the Engineer should the equipment and materials be delivered to site.

**E.** Submit to the Engineer full details and particulars of all equipment and materials proposed for use and no material shall be ordered, delivered or constructed without a written approval from the Engineer. Any material or equipment, which is not approved but installed, shall be removed and reinstalled with approved one at the Contractor's expense.

**F.** The details 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.
4. Short circuit study including all components shown on the Schematic Diagrams.

**G.** Submit, at the request of the Engineer, a sample of any equipment or material for further study before approval.

**H.** Manufacturers specified by name are not relieved of the responsibility for meeting Specification requirements and submittal for approval.

**I.** No order shall be placed by the Contractor for major material or equipment unless written approval of the Engineer has been obtained. The Contractor shall report monthly progress of the purchase orders to the Engineer submitting to him a copy of the orders.

*PART 3 – EXECUTION*

## 3.01 WORKMANSHIP

**A.** The works shall be executed in a neat, substantial and workmanlike manner. All workmanship shall be strictly first class in every respect and shall be performed only by skilled workmen.

**B.** Whether or not shown on the Drawings, equipment shall be installed in such a manner that equipment, operating and control devices ...etc. are readily accessible for service and adequate access spaces are maintained.

**C.** Obtain detailed information from the manufacturers of equipment as to proper method of installation and connection of these equipment.

**D.** Should any portion of the Contract works which should reasonably and obviously be inferred as necessary for the complete, safe and satisfactory operation of the electrical installation as a whole, but not expressly described or specified, provide and execute such works as part of the Contract.

## 3.02 CONTRACTOR'S REPRESENTATIVE, STAFF AND WORKMEN

**A.** The Contractor shall keep permanently on the site, a competent Senior Electrical Engineer, having an experience of not less than 10 years, as his representative fully experienced and who has executed as Superintendent of electrical installation works of the type and scale similar or larger than this Project.

**B.** The Contractor shall submit to the Engineer the Schedule of Proposed Contractor's Engineers Senior Draftsmen and Senior Foremen employed for this Project stating the names, nationalities, ages, qualifications and detailed experience before proceeding with the Works. The Contractor shall from time to time supply any further personnel in addition to those proposed and approved as may be necessary to ensure the satisfactory progress of the works.

## 3.03 IDENTIFICATION AND LABELLING

**A.** The components of all main and sub-main switch boards, all distribution boards, switches, isolators and other items of plant shall be clearly identified by means of labels secured to the external surfaces of the units designating the function of these units.

**B.** The labels shall be 2mm. "Traffolite" of minimum size 50 x 20mm with 5mm black lettering on white background fixed securely to front plates of distribution boards, switches, circuit breakers, isolators, starters, push buttons, lamps instruments ...etc.

**C.** In addition to this each distribution board shall also be provided with circuit schedules fixed rigidly inside the door of the board and indicating the number, rating, type of load and location of each circuit in the board.

**D.** Each end of each cable shall be provided with identification labels lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, ...etc.

**E.** Manufacturers name plates shall include manufacturer's name, model or type number, serial number and all applicable ratings clearly marked thereon. The name plates shall be placed in a conspicuous location on the equipment.

## 3.04 TESTING AND COMMISSIONING

**A.** On completion of the entire electrical installation work or any separate or distinct part thereof, notify the Engineer, in writing, that the completed part of the electrical work is ready for inspection. Before doing so, perform initial trial tests. Test, correct, adjust, balance, regulate, ...etc. the section concerned as necessary until required conditions are obtained.

**B.** The inspection of the Contract work shall be carried out in the presence of the Engineer and in accordance with the requirements of Section 'E' of the IEE 'Regulations for Electrical Equipment of Buildings' and shall comprise of but not be limited to:

1. Verification of polarity.
2. Effectiveness of earthing.
3. Insulation resistance test.
4. Test of ring circuit continuity.
5. Phase rotation.
6. Operation tests of relays, interlocks and any other protective and control device to ensure correct functioning.

The results and readings obtained shall be equal or better than the requirements of the IEE and the local authorities regulations and these shall be recorded on forms similar to the ones described in the IEE regulations.

**C.** Supply all instruments and tools required for carrying out the tests.

**D.** In case that the above mentioned tests are satisfactory and no errors or faults appeared in the installation, submit the necessary test forms duly filled, to the local authorities and to repeat, if necessary, the tests in the presence of the local authorities Inspector.

**E.** Follow-up and make all necessary arrangements with the local authorities for the purpose of providing permanent electricity supply and telephone service. Also provide all facilities and attendance to the local authorities for any other tests carried out before energizing the installation.

**F.** After the connection of the supply to the installation, commission all parts of the electrical installation covered by this Specification and demonstrate to the Engineer that the entire electrical installations are in perfect working order.

**G.** When equipment or services of a specialized nature are involved, and if it was found necessary, provide the services of a specialist from the manufacturer who shall be present at the time of testing and commissioning of this equipment. Include for all expenses incurred in this respect as no claim for additional payment will be entertained.

**H.** Acceptance certificate will not be issued until all testing and commissioning has been carried out to the satisfaction of the Engineer and local authorities. After local authorities 's final approval microfilm of as-built drawing shall be given to the Engineer for permanent record.

**I.** An amount equal to 5% of the contract value for the Electrical, Communication and Electronic works will be retained till the completion of all commissioning. This amount is in addition to the 10% retention money, which will be release after the completion of 2 years of maintenance contract.

## 3.05 OPERATION AND MAINTENANCE MANUALS

**A.** Submit to the Engineer, at the same time of submitting "Record Drawings", properly printed and bound copies of service manuals for the electrical installations to describe the various systems in the fullest details that permit application of proper maintenance, replacement of parts and awareness of system characteristics. These shall include the following:

1. Manufacturer's technical catalogues, dimensional drawings and wiring diagrams for each and every type of equipment installed.
2. Operating instructions for various equipment and systems included in the installation work.
3. Maintenance manuals for all equipment and systems included in the installation work, which need regular and specialized maintenance.
4. Spare parts list with part numbers of various components of all equipment used in the installation work.

## 3.06 OPERATION AND MAINTENANCE DURING TWO YEAR MAINTENANCE PERIOD

**A.** Include for Operation and Maintenance including Preventive Maintenance during the two (2) year Maintenance Period.

**B.** Include all spare parts for replacements made necessary due to wear and tear of equipment, consumable parts, short life parts, oils, etc. and all maintenance tools and equipment required for proper operation and maintenance of the Works, the contractor should submit a list of spare parts to be included with his offer for each item.

**C.** Include for sufficient personnels to be on call for 24 hours 7 days a week

**D.** Include all routine and preventive scheduled maintenance as recommended by the equipment manufacturers to keep equipment in perfect operating condition.

**E.** Keep all records, logbooks, log sheets, maintenance job cards ...etc. in neat order to the satisfaction of the Engineer. All records, log books, and log sheets, charts, maintenance job cards, ...etc. shall become the property of the Employer.

**F.** Provide all necessary maintenance and operation staff experienced in both electrical and mechanical work such as engineers, foremen, operators, electricians, mechanics, helpers....etc. for effective maintenance and operation of all systems. Submit to the Engineer for approval qualification details of all maintenance and operation staff.

**G.** During the Maintenance Period operate, control, maintain, replace and repair any part of plant or material within the Electrical Works Systems which may prove defective due to Contractor's design, erection, operation, performance, or workmanship, or prove defective from any act or omission that may develop from use in the Works or any section thereof.

**H.** Be responsible for training the Employer's personnel in the correct operation, control and maintenance of the Electrical Works Systems. Training shall be carried out by qualified commissioning and operating staff of the Contractor.

**J.** The foregoing Clauses are in addition to and in no way relieve the Contractor of his liabilities and obligations under the Contract.

## 3.07 GUARANTEE

**A.** Manufacturer's shall provide their standard guarantees for products furnished under this Contract. However, such guarantees shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.

**B.** All materials, items of equipment and workmanship furnished under this Contract shall carry standard warranty against all defects in materials and workmanship. Any fault due to defective or improper material, equipment, workmanship or Contractor's design which develop shall be made good, forthwith, by and at the expense of the Contractor, including

all other damage done to areas, materials and other systems resulting from this failure.

**C.** Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

## 3.08 SPARE PARTS

**A.** **Spare Parts during Two years Maintenance Period:**
Contractor shall provide all spare parts required during the two (2) years maintenance period at NO cost

**B.** In special cases the spares have been listed in the sections. In all other cases manufacturer's recommened spares shall be provided.

***** END OF SECTION *****

# General Provisions for Electrical Work

## Part 1-General

### 1.01 Work Included

All electrical work shown on the drawings or mentioned in B.O.Q.

### 1.02 Quality Assurance

A. General Provisions contained in this section, shall apply and form a part of each and every section of specification, Division 16, Electrical.

B. The Contractor shall verify that the materials, appliances, equipment or devices he furnishes and installs under this Contract, meet the requirements of the specified codes and standards. The label of, or listing by an independent institute will be accepted as conforming with this requirement. In lieu of the label or listing. The Contractor shall submit independent proof for review by the Supervising Engineer that the materials, appliances or devices conform to established standards, including methods of test, of the country of origin.

C. In addition to the requirements shown or specified in the Contract Documents, all equipment shall be manufactured, tested and installed in accordance with the latest editions of the following standards as listed:

1. IEC International Electrotechnical Commission.
2. BS British Standards.
3. ISO International Standards Organization.
4. VDE Association of German Electrical Engineers.
5. IES Illuminating Engineering Society.
6. Municipality Regulations.
7. Regulations and instructions of Civil Defense Department.

D. Codes and Standards listed in the specification sections are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they are of equal or better quality than the reference codes and standards and are submitted for review and approval by the Supervising Engineer.

E. All items of labor and material required to comply with such standards and codes in accordance with the requirements of the Contract Documents shall be included. Where quantities, sizes or other requirements indicated on the drawings or herein specified are in excess of the requirements of the standards and codes, the specifications and /or drawings shall govern.

F. The electrical drawings shall serve to indicate the general layout of the various items of equipment. However, layout of equipment, accessories, specialties and wire ways are diagrammatic unless specifically shown and /or dimensioned.

G. The General arrangement of circuiting and equipment shall be as shown on the drawings. Detailed drawings and proposed deviations due to actual field conditions or other causes shall be submitted to the Supervising Engineer for review. The Contractor shall carefully examine all drawings and shall be responsible for the proper fitting of materials and equipment in each location as indicated, without substantial alterations. The Contractor shall carefully investigate the structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing such fittings and accessories as may be required to meet such conditions.

H. The motor and apparatus wattage ratings shown on drawings are estimated values. The corresponding sizes of feeders and other electrical equipment indicated to serve them shall be confirmed by the Contractor. Motors and apparatus with larger wattage ratings may be furnished if necessary to meet the requirements of the various sections of the specification in which they are specified. Where larger motors or apparatus with larger wattage ratings are furnished, the feeders and other electrical equipment serving them shall be suitably increased. The increase in the capacity of the feeder and equipment shall be furnished at no additional cost to the Client.

**1.03 Submittals**

A. Shop Drawings: The Contractor shall submit for review by the Supervising Engineer, detailed dimensioned shop drawings as stipulated in other sections of Specification Division 16, Electrical. These drawings shall be prepared by the Contractor, shall base on manufacturers installation instructions and shall not be reproductions or tracings of the design drawings. In preparing shop drawings, lines and levels for the work specified shall be established and the drawings shall be checked thoroughly to avoid interference with structural features and the work of other trades. Shop drawings and /or data sheets shall be based on information

stated in the specifications and as shown on the drawings and shall show all pertinent information and data for the fabrication and complete installation.

Material Submittals: Shall be made for 3 different manufacturers. Energy saving equipment /materials shall be given preference.

B. Manufacturer's Literature: Manufacturer's data sheets shall be submitted indicating the necessary installation dimensions, weights, materials, and performance information. The performance shall include complete electrical data, including power conditions and identifying types and numbers. Where pertinent, electrical diagrams shall be provided. The above information may be provided by standard sales catalogue sheets marked to indicate the specific equipment provided.

C. Operations and Maintenance Instructions: The Contractor shall furnish data covering model, type and serial numbers, capacities, maintenance and operation of each major item of equipment or apparatus in accordance with the requirements of the Contract Documents. Operating instructions shall cover all phases of control.

D. Spare Parts: The Contractor provide as part of this contract sufficient spare parts required for maintenance of two years of operation after handing over, together with spare parts lists in accordance with manufacturers' recommendations and as directed by the project supervisor.

**1.04 Product Handling**

A. The Contractor shall be responsible for keeping stocks of material and equipment stored on the premises in a neat and orderly manner.

B. The exposed surfaces of wire ways, conduit systems or equipment which have become covered with dirt, plaster or other material during handling and construction shall be thoroughly cleaned by the Contractor, before such surfaces are prepared for final finish, painting, or enclosed within the building structure.

C. The Contractor shall clean and maintain the work in accordance with the Contract stipulations.

**1.05 Protection**

A. The Contractor shall keep all raceways and conduit system openings closed by means of plugs or caps to prevent the entrance of foreign matter and cover all fixtures, equipment and apparatus as required to protect them against dirt, water, chemical or mechanical damage both before and after installation.

B. Plugs and caps shall be of such types as to prevent transmission of flood water through any duct, conduit or raceway. Any fixtures, equipment or apparatus damaged prior to final acceptance of the work shall be restored to its original condition or replaced by the Contractor. At completion, fixtures and equipment shall be thoroughly cleaned.

C. The Contractor shall be held responsible for all damage done until his work is fully and finally accepted.

**1.06 Coordination**

A. The Contractor shall be held responsible for the proper coordination of all phases of the work under this Contract.

B. It shall be the responsibility of the Contractor to coordinate the work and equipment as specified herein with work to be performed and equipment to be furnished, under other sections of the specifications in order to assure a complete and satisfactory installation.

**1.07 Quality of Equipment**

Quality shall be of the best grade for each type or class, even through such quality may not be stated specifically in the specifications. All materials and products shall be new and manufactured by well known firms and shall be sound and uniform in quality, size, shape, color and texture and shall be free from cracks, warpage, or their defects. Energy consuming equipment shall be of the energy saving type, wherever relevant and applicable.

**1.08 Temporary Power**

A. The Contractor shall furnish and install all temporary electrical facilities, including lamps, required for construction and safety operation. All such equipment shall remain the property of the Contractor and shall be removed when permanent connections have been completed. Where it is determined, during construction, that the temporary facilities, as installed, interfere with other

construction operations, the Contractor shall relocate said facilities in an approved manner. No wire, bus or electrical equipment which is part of any of the permanent electrical systems may be used for temporary electrical service for construction operations.
Temporary connections shall be safe in accordance with accepted practices. The Contractor shall be responsible for any damage or injury to equipment, materials or personnel caused by improperly protected temporary installations. All costs for materials and installation for temporary electrical facilities and energy for their operation shall be at the expense of the Contractor.

B. Electrical welders used in the erection and fabrication of the building and its equipment shall be provided with an independent grounding cable connected directly to the structure on which the weld is being made rather than to adjacent conduit, piping, etc.

**1.09 Manufacturer's Nameplates**

Each major component of the equipment wherever possible shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable. Code Ratings or other data which are die-stamped into the surface of the equipment shall be stamped in an easily visible location.

**1.10 Metering**

Metering shall be provided for at the locations indicated on the Drawings.

**1.11 Site Service Conditions**

All equipment located in air out-of doors shall be capable of operating continuously under the prevailing conditions regarding dusty atmosphere, altitude and prevailing ambient temperatures (dry bulb).

**1.12 Electrical Utilities**

A. Power supply to the site will be at 11000 Volts, ±5%, 3 phase, 50Hz. The interface with the utility company incoming supply is the KWH meter.

B. The Contractor shall make his interface with the incoming primary telecommunications cable(s) at the site boundary in the manner shown on the Drawings.

## Part 2 Products

### 2.01General

A. Except for those items as may be specified in Part 3 of this Section, refer to Part 2 of the various sections of the specification, Division 16, Electrical.

## Part 3 Execution

### 3.01 Workmanship

Materials, products and equipment furnished by the Contractor, shall be installed and all work shall be performed in a first-class workmanlike manner, in conformity with the best trade practices and the printed directions of the applicable manufacturers; by skilled workers equipped to produce satisfactory results; in a safe, substantial manner so as to avoid undue stresses, rigid enough to prevent undue movement, so as not to interfere with work of other trades and so as to preset a neat, orderly appearance and to facilitate operating, servicing, maintaining and repairing.

### 3.02 Foundations and Supports

A. The Contractor shall provide concrete pedestals, bases pads, curbs, anchor blocks, anchor bolts, slab inserts, hangers, channels, cradles, saddles, etc.., for installation of equipment and apparatus shown on the drawings and specified in the various sections of specification Division 16, electrical.

B. Concrete pads shall be 150mm high, unless otherwise indicated, complete with steel reinforcing and necessary bolts, anchors, etc. Where concrete pad is set directly on concrete floor, dowels in floor to tie base to floor shall be provided. These pads shall be extended at least 100mm beyond the equipment outline on all four sides.

C. Individual hangers, trapeze hangers and riser clamps shall be provided for supporting conduit and all parts and hardware shall be zinc-coated (galvanized).

D. Pipe straps and hanger rods shall be fastened to concrete by means of inserts or expansion bolts, to brickwork by means of expansion bolts and to hollow masonry by means of toggle bolts. Wooden plugs and shields shall not be used for fastening pipe strips and hangers.

E. Under no circumstances shall duct work, piping and mechanical equipment be used for supporting electrical facilities.

**3.03 Sleeves, Chases and Openings**

A. Pipe sleeves for all electrical conduit passing through walls, partitions, ceiling, floors, etc.., shall be of sufficient length to extend through the full thickness of the construction, with ends flush with the finish on each side, unless noted otherwise.

B. The Contractor shall provide necessary chases and openings in the walls, partitions and floors to accommodate his work.

C. Chases, sleeves and openings in fire rated walls and floors (telephone, electrical closets, etc.) shall be packed with acceptable mineral wool insulation or approved flexible barriers designed for the purpose shall be used. Only UL or similar listed and certified material shall be installed. The fire rating shall not be less than the related wall.

D. Whenever any of the work of the electrical system has to pierce any water proofing, this work shall be done with care and after the part of the system has been put in place through this waterproofing, the opening made by same shall be waterproofed and made absolutely watertight.

**3.04 Cutting and Patching**

A. The Contractor shall provide chases, holes and openings for the installation purposes and carefully fit around, repair, patch and otherwise make his work acceptable.

B. He shall furnish and install all sleeves and inserts required for this work. Cutting and patching of any part of the structure shall be done only after review by the Supervising Engineer.

**3.05 Access Panels**

Access panels shall be installed where indicated and as required for access to equipment and apparatus. Where, in the opinion of the Contractor access panels are required, but are not shown on the drawings, the Contractor shall provide same and relocate same on the as-built drawings.

**3.06 Painting**

A. All shop fabricated and factory built equipment not galvanized, plated or provided with standard finish paint, shall be cleaned and given one shop coat of lead free primer paint, before delivery to the sit. Under no circumstances, shall the nameplate, label or tag of any equipment be covered with field painting.

B. The exterior of electrical panels, panel boards, cabinets, switchgear, transformers and the like shall be finished in ANSI 61 gray. The interiors shall be finished in a light or white colour.

**3.07 Touching Up**

A. Painting: Damaged or inadequate paint films of shop painted miscellaneous metal materials, and all accessible surfaces of field welds and connection bolts, shall be cleaned and prime painted. Touch up paint for shop primed materials and ungalvanized bolts shall be the same as that used for the shop coat.

B. Galvanizing: Galvanizing surface scratched or otherwise damaged during delivery, unloading, or erection shall be thoroughly cleaned by wire brushing the damaged area to remove all loose, cracked or bruised galvanizing. Cleaned areas shall then be painted with zinc rich galvanizing paint of an inorganic zinc compound of zinc dust and zinc oxide, with the zinc dust content of 75 per cent or better by weight of the total nonvolatile content. Application of touch up galvanizing shall be applied at a dry film thickness of at least 0.75mm.

**3.08 Tests**

A. Prior to starting the electrical installation, the Contractor shall verify the correct voltage, phases and current consumption of all utilization equipment to be voltage, phases and current consumption of all utilization equipment to be connected. Branch circuit wiring, voltage and circuit breakers must be adequate in each case.

B. The contractor shall provide any materials, equipment and labor required and make such tests as specified in the various sections of Division 16 and as deemed necessary to show proper execution of the work.

C. Any defects or deficiencies discovered as a result of such tests shall be corrected without additional cost.

D. After the installation is complete and properly adjusted, the Contractor shall conduct operating tests. The various equipment and systems shall be demonstrated to operate in accordance with the requirements of the Contract Document. The Contractor shall provide electric power, instruments and personnel necessary for performing the various tests.

**3.09 Equipment Connections and Motor Starters**

A. In addition to electrical work, the Contractor shall make all electrical connections to mechanical and medical equipment furnished under other sections i.e. the Plumbing, Heating, Air Conditioning and Ventilation Sections of Division 15.

B. Unless otherwise specified, the Contractor shall mount and align all starters, control devices, safety switches and other related electrical equipment whether specified in this or other sections of the specification, except where such items are factory mounted to the driven equipment. The mounting and alignment of motors, starters, control equipment etc.., for which the feeders are terminated in safety switches as hereinafter specified, are included in the sections of Mechanical Sections, in which the motors etc.., are specified.

C. Unless otherwise specified, the Contractor shall furnish all wiring, including conduit, wire, junction boxes, disconnecting switches, overcurrent protection, etc.., not specified elsewhere in this specification, to and between all motors, starters, control devices and related electrical equipment whether specified in this or other sections of the specification, except where such items are factory wired as well as factory mounted on the driven equipment. All wiring from the above

termination points to and between motors, starters and control equipment associated with the equipment named, is included.

D. Wiring for temperature control equipment is specified under this division.

E. Unless otherwise specified, all wiring to motors, control equipment and related electrical equipment, shall be run in rigid metallic conduit with flexible connections where required. Conduits shall be large enough to accommodate motor feeders, grounding conductors and control wires, whether or not so indicated on the Contract Drawings. Wire sizes shall be as shown and as required by the IEC Codes.

**3.10 Equipment Erection**

A. General: All electrical equipment shall be erected or installed in accordance with the maufacturer4s' recommendations, good electrical engineering practice, and the relevant drawings and specifications.

B. Location Tolerances: Equipment shall be located within 3mm of the dimensional location on the Contract Drawings, unless otherwise permitted by the Supervision Engineer.

C. Lubrication: The Contractor shall furnish a lubrication system schedule and all oils, greases, and other lubricants in accordance with the manufacturer's recommendations, to the Supervising Engineer's approval.

D. Insulating Oil: the Contractor shall furnish all insulating oil required for oil insulated equipment. As soon as possible after receipt of the oil, the Contractor shall sample the oil in accordance with the code for dielectric acceptance.

**3.11 bolted Electrical Connections**

A <u>General</u>:

1. Where bolted connections are made to aluminum surfaces, the aluminum surface shall be thoroughly cleaned with a wire brush, then coated with joint compound and thoroughly brushed again through the compound. Additional compound shall then be added and the joint together.

2. Where bolted connections are made between copper or brass surfaces, the metal surfaces shall be thoroughly cleaned and coated with a corrosion thoroughly inhibiting compound.

3. The tightness of each bolt in each factory made bolted electrical connection shall be checked during erection and connection of the equipment.

4. It shall be the Contractor's responsibility to certify that the tightness of each bolt in all bolted electrical connections, factory or field, is in accordance with the manufacturer's recommendations.

5. bolted electrical connections shall be tightened with manual torque wenches. Torque wenches shall be so constructed that they will visually or audibly indicate when the proper torque is reached. The accuracy of each torque wrench shall be checked by a testing laboratory acceptable to the Supervising Engineer immediately prior to its use on equipment erected under these specifications.

B. Connection Bolt Tightness Check:

1. The tightened bolts in electrical connections shall be checked at random as selected by and in the presence of the Supervising Engineer. The Contractor shall provide calibrated hand torque wrenches and the necessary platforms equipment, and personnel for the random check.

2. The number of bolts checked shall be acceptable tot eh Supervising Engineer based upon their observance of the quality and completeness of the tightening operations. A minimum of 10 per cent of the bolts in each connection, but not less than two bolts in each connection, shall be checked.

3. The Contractor shall be responsible for coordinating the checking of bolt tightness so that minimum interference with equipment erection and connection will be experienced. Removal of covers and similar dismantling of equipment to permit the Supervising Engineer to witness the testing of bolt tightness of enclosed connections shall be part of the work included under these specifications.

4. Checking of tightness of electrical connections in the presence of the Supervising Engineer is intended to assist the Contractor in avoiding the expense of repairing costly connection failures. This check shall not relieve the Contractor of complete responsibility for the integrity of the electrical connections.

### 3.12 Short Circuit and Protective Device Coordination Studies

A. It is the responsibility of the Contractor to check the information given in the Project Documents about voltages and frequency with the Electric Power Company and confirm the data in writing to the Supervising Engineer.

B. Conductors and equipment shall be protected against overcurrent in accordance with their rated ampecities. An overcurrent device shall be connected at the point where the conductor or equipment to be protected receives its supply.

C. Provide four (4) brochures, each of which shall include complete short circuit and protective coordination studies, complete with device coordination time-current curves for the entire power distribution system.

D. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, impedance diagrams, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each medium voltage switchgear line-up, unit substation medium voltage terminals, low voltage switchgear line-up, switchboard, motor control center, distribution panel board, pertinent branch circuit panel board, and other significant locations throughout the system. Provide a ground fault study for each medium voltage system, including the associated zero sequence impedance diagram. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.

E. In the protective device coordination study, provide time-current curves on the Log-Log sheets indicating the coordination proposed for the system, centered on conventional full-size log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective identifying its type, function, manufacturer, and time-current

characteristic. Tabulate recommended device tap, time dial, pick-up, instantaneous, and time delay settings.

F. Include on the curve sheets power company relay and fuse characteristics, medium voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker trip device and fuse characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include tolerance and damage bands in plotted fuse characteristics.

G. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, magnetic in rush current point and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

H. Select each primary protective device required for a delta-star connected transformer so that its characteristics or operating band is within the transformers characteristics. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristics by a percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

I. In each brochure, include complete sets of individual protective device time-current characteristics on transparencies.

J. The short circuit and protective device studies may be prepared with a network analyzer, digital computer or by written computations, but must include complete fault calculations as specified herein for each proposed and ultimate source combination.

K. The plans and specifications indicate the general requirements for the electrical equipment being provided under this contract. Changes and additions to equipment characteristics may be suggested by the results of the short circuit and protective device coordination studies. Submit any such proposed changes and additions as a part of the study brochure material. Necessary field settings of devices, and adjustments and minor medications to equipment to accomplish conformance with the approved short circuit and protective device coordination

studies shall be carried out by the particular manufacturer or by the Contractor at no additional cost to the Owner.

### 3.13 Equipment Testing and Commissioning

A. General: The testing of all electrical equipment shall include, but not be limited to, the items below. This shall be in addition to testing specified elsewhere in this specification.

1. General Equipment check.
2. Field wiring and ground system verification.
3. Conductor insulation tests.
4. Equipment adjustment.

The Contractor shall be responsible to make arrangements for power required for testing and commissioning purpose. The testing shall be a continuous process to maintain the construction schedule to the satisfaction of the Supervising Engineer. The Supervising Engineer shall have full access to observe all facets of the testing. All terminals, connections and attachments, all covers, insulating fittings, supports, hardware and field mounted accessories shall be checked for proper tightness.

B. Cable: Testing of all cable furnished and installed under this specification shall be in accordance with all related sections.

C. Grounding: Testing and grounding of equipment and cable, shall include, but not be limited to the tests below:

1. Earth continuity tests shall be made from each item of equipment to the appropriate main ground system and on the main ground system to the ground rods.
2. The resistance to ground for selected ground rods:

All ground resistance measurements shall be made with a three terminal “megger” type ground tester which applies alternating current to the electrodes and which gives a reading in direct current ohms. Two reference ground probes shall be used and all tests shall be made in accordance with the instrument manufacturer’s instructions for ground resistance testing. Prior to connection of ground rods to the grounding system the Contractor shall obtain individual measured ground resistance data from selected ground rods as indicated on the drawings. These data shall be obtained, identified, and recorded under the supervision of the Supervising Engineer and the results sent to the Supervising Engineer within five days.

After connection of ground rods to each manhole's grounding mat, the Contractor shall obtain a ground resistance measurement from a flush ground plate. These data shall be obtained, identified, and recorded and the results sent to the Supervising Engineer within five days.

The ground resistance measurement data may indicate that additional ground rods are required. The Contractor shall furnish, install, and connect additional ground rods as the Supervising Engineer may direct.

D. Operation Control

The Supervising Engineer will establish a system of operation control as the permanent equipment and systems are completed and capable of energization.

The system will consist of placing appropriate tags on each item of equipment and each system component indicating its current status and requiring mandatory clearances from designated personnel to operate, energize or remove from service the equipment or systems. The controls established will encompass the following phases:

1. Equipment or systems completed to the point where they may be energized, pressurized or operated but not yet checked out will be tagged and the sources of power or pressure will be turned off and tagged. The affected components shall not be operated without clearance.

2. Following initial operation of the equipment or system, tagging will be performed as in 1 and the affected components shall be operated only by the personnel designated by the Supervising Engineer.

3. Equipment and systems released for service will be so tagged. Only the personnel so designated by the Supervising Engineer shall operate or remove from service such systems or equipment. When a request to remove from service is made, all controls and sources of power or pressure will be tagged out and shall be operated under any circumstances. Only the personnel originally tagging the system shall clear the system from service.

The Supervising Engineer will establish the procedures and details of the operation control system. All notification of status and requests for clearances for operations shall be made to the Supervising Engineer. The procedures established shall be followed.

***** End of Section*****

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# ELECTRICAL IDENTIFICATION

## PART 1 GENERAL

1.01 SECTION INCLUDES

**A. Electrical identification to identify all electrical items for easy operation and maintenance including, but not limited to the following:**

1. Nameplates and labels.
2. Wire markers.
3. Colour coding of raceways.
4. Circuit identification charts.
5. Cable identification tags.
6. Cable warning tapes.
7. Cable markers.
8. Equipment warning/danger signs.

**1.02 RELATED SECTIONS**

| | | |
|---|---|---|
| A. | Section 09900 | Painting. |
| B. | Section 16050 | Electrical Wiring, General. |

1.03 REFERENCES

| | |
|---|---|
| IEC 364 | Electrical Installations |
| BS 7671 | Electrical Wiring Regulation (IEE 16th) |
| IEC 391 | Marking of Insulated Conductors |
| IEC 445 | Equipment Terminals (Identification of Equipment Terminals and Terminations of Certain Designated Conductors). |
| IEC 446 | Identification of Bare Conductors by Colors or Numerals. |

1.04 SUBMITTALS

**A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:**

1. Name of the manufacturer.
2. Country of origin.
3. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
4. Technical performance of the equipment selected.
5. Dimensional details needed for installation and maintenance.
6. Delivery time from the date of orders.
7. Copies of test reports or certificates.
8. Control schematics and wiring diagrams.

**B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.**

**C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product Testing Agency and include instructions for storage, handling, protection, examination, preparation and installation of the product.**

1.05 QUALITY ASSURANCE

**A. Manufacturers: Firms regularly engaged in manufacture of items the types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. Preference shall be given to local manufacturers and agents/suppliers.**

**B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.**

**C. All items of Electrical Identification shall be comply with the requirements of BS and Local Standards Organization.**

## PART 2 PRODUCTS

2.01 NAMEPLATES AND LABELS

**A. Nameplates and labels shall be engraved on a three-layer 2 traffolyte plate having minimum thickness of 2 mm, securely screwed to the housing and have black letters on white background in Arabic and English.**

**B. The name plates and labels shall be required for each electrical distribution board, control panels, equipment enclosures, substation equipment, disconnect switches and equipment cabinets.**

**C. Lettering shall be block capitals standing :**

6 mm high for identifying individual equipment and loads.

10 mm high for identifying grouped equipment and loads.

**D. Labels using embossed adhesive tape with 6mm white letters on black background or transparent adhesive tape with 6 mm black letters, as selected by the Engineer, shall be used for identification of individual wall switches, receptacles, low current outlets, speakers, control device stations, junction/pull boxes, electrical boxes and fittings, etc.**

2.02 WIRE MARKERS

**A. Wire markers shall be split sleeve or tubing type.**

**B. The wire markers shall be required for each conductor at panelboard gutters, pull boxes, outlets, junction boxes and each load connection.**

**C. All power and lighting circuits, branch or feeder circuits and control circuits shall require wire markers.**

2.03 COLOUR CODING OF RACEWAYS

**A. Provide color bands with printed description of each system, minimum 75 mm wide for all cable trays/ladders and trunking runs. These color bands shall be applied at each electrical distribution/panel board, low current system control panels and junction box locations and at 15 m centers within an area.**

**B. Provide color bands with printed description of each system, minimum 25 mm wide for conduits up to 25 mm in diameter and one-half the conduit diameter for larger conduits, applied at panel and pull box locations, within each room, and at 6 m centers within an area.**

**C. Following color banding shall be used for the raceways of various electrical systems, however subject to final decision of the Engineer. Color bands for the electrical systems not described here shall be as agreed on site:**

1. Lighting: gray.
2. Normal Power: brown.
3. Essential Power : black
4. Earthing : green.
5. Fire alarm : red.
6. Telephone : blue.
7. Sound : yellow.
8. Data : purple.
9. Television : rust.

2.04 CIRCUIT IDENTIFICATION CHARTS

**A Individual circuit identification charts shall be provided for all panelboards, distribution boards, control panels, etc. giving following information as a minimum.**

1. Circuit numbers
2. Phase
3. Load names with location.
4. Connected load.
5. Outgoing terminal numbers.

6. Sizes and types of protective devices.
7. Sizes and types of incoming and outgoing cables.
8. Contacts location references of relays and other control devices (if any).

**B. Charts shall be typed on A4 size sheets. They shall be enclosed in a clear plastic envelope and shall be securely fixed to the inside cover of the unit. Additional copies of the charts shall be included in the Operation and Maintenance Manuals.**

2.05 CABLE IDENTIFICATION TAGS

**A. All cables which exit from manholes, vaults, handholes, and transformer or switch enclosures shall be properly tagged or labeled. Tags shall be permanent, non-corrodible and clearly readable. Tags should include the information listed below for the various circuit categories:**

Primary Cables - 11 kV
Feeder Name
Voltage
Phase (for single conductor cables)

B. Cable identification tags for wire and cable circuits shall be of an opaque nylon material arranged to include a marker plate, non-releasing nylon ties, and cable fastening tail. One side shall be roughened to hold black nylon permanent ink. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device, and prevent removal of the tail without cutting it loose from the marker. Cable identification shall be inscribed in Arabic and English.

2.06 CABLE WARNING TAPES

A. For buried LV and HV cables use warning tapes according to the standard practice of Electricity Supply Authority and applicable international standards.
B. Cable warning tapes shall be of polythene, not less than 150 mm wide and at least 0.25 mm thick. They shall be yellow in color for LV and MV cables and bear the continuously repeated legend – “CAUTION ELECTRIC CABLE BELOW” or similar in English and Arabic, in black letters not less than 30 mm high.

C. For buried low current/communication cables or duct banks, use warning tapes as per the standard practice of Local Telecom Supplier and applicable international standards.

## 2.07 CABLE MARKERS

A. Buried cables shall be permanently identified by concrete markers. The markers shall be 600 mm square x 100 mm thick with impressed character; they shall be made of grade 20 concrete, with 10 mm aggregate. The impressed characters shall be in English and Arabic and worded "HV CABLE" or "LV CABLE" as appropriate together with circuit details as required for proper identification. In addition, the word “JOINT” shall be added to above words, where applicable.

B. Except where cables are buried, located in switchrooms, in ducts and spaces designated solely for electrical services, or have orange oversheaths; they shall be identified by adhesive bands colored orange, complying with standards and codes of practice mentioned elsewhere in the Specifications. The bands shall be not less than 100 mm long, located at least once within each separate compartment through which cables pass and at intervals not exceeding 12 m.

C. Except where cables are buried or enclosed in conduit, trunking or ducting; they shall be permanently identified by discs. The discs shall be of laminated plastic materials with black character on white; character shall be not less than 3 mm high. The inscription shall indicate the nominal voltage, the designation of the load, the number and cross sectional area of cores and the rated voltage of the cable.

D. Cables identification discs shall be attached to the cables with ties. Disc shall be located within 500 mm of terminations and joints, at least once within each separate compartment through which the cable passes, and at intervals not exceeding 24 m, they shall coincide with the colour bands.

## 2.08 EQUIPMENT WARNING/DANGER SIGNS

A. For external use, pressure sensitive danger signs shall be used. Dimensions shall be as approved by the Engineer. The signs shall be heavy duty vinyl with a self-adhesive backing which can be applied to curved or irregular surfaces. Danger signs shall be weather-resistant and shall not discolor or deteriorate with age.

B. Danger signs shall be inscribed with the equipment voltage level along with an internationally recognized danger sign.

C. Warning/Danger signs made of red plastic (vinyl) with white letters at least 25 mm high reading "DANGER High Voltage" shall be fixed to the entrance doors of all 11 kV switchgear and transformer rooms.

D. Warning/Danger signs made of red plastic (vinyl) with white letters at least 15 mm high reading "DANGER 380V"or “DANGER 220V” as appropriate, shall be fixed to the lids, covers or doors of any equipment which contains terminals or conductors connected to more than one phase of a low voltage supply.

E. All signs shall be in English and Arabic.

2.09 LANGUAGE

A. The Arabic and English languages shall be used for all labeling and charts.

## PART 3 EXECUTION

3.01 PREPARATION

A. De-grease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

A. Install warning and descriptive labels as follows :
   1. Metallic surfaces using stainless steel or chromium plated bolts and/or self tapping screws.
   2. Concrete surfaces or masonry walls using and brass wood screws.
   3. Timber surfaces using minimum 6 mm countersunk brass screws.
   4. All insulated enclosures using an approved plastic welding adhesive.

B. The danger sign and identification number shall be affixed to the front or access doors of all transformers and switches. For equipment with two doors the danger sign shall be mounted on the left door with the identification number mounted on the right door. Both the danger sign and the identification number shall be centered 300 mm below the top edge of the doors and on the vertical centerline of each door.

C. On equipment with only one access door, the danger sign and the identification number shall be centered on the vertical centerline of the door, with the horizontal centreline of the danger sign 300 mm below the top edge of the door and the horizontal centreline of the identification number 250 mm below the danger sign centerline.

D. Locate cable markers at every point where cable(s) enter a building, sub-station, distribution/feeder pillar; at each joint, change of direction, road/pathway crossing, etc. Cable markers shall also be provided along the straight runs (route) of the cable(s) at the interval not exceeding 30 m.

***** END OF SECTION *****

# CONDUITS

## PART 1 – GENERAL

### 1.01 GENERAL

A. PVC conduits shall generally be allowed in CAST-IN-SITU. Surface installed Conduits (below or above false ceiling) shall be rigid steel (GI). Where heavy protection against mechanical damage is required only rigid steel (GI) conduit shall be used.

B All conduits and conduit fittings shall comply with concerned local authorities Specifications

C In precast concrete slabs etc. GI conduit shall be used

D All conduits are fire retardant colored for all systems even if used in concrete slabs.

### 1.02 CONDUIT SYSTEM

Conduit system shall be provided including all necessary fittings, supports, Accessories, all other hardware complete as required.

For underground installation UPVC conduit shall be used

All materials for caulking and sealing conduits, pipes, sleeves etc through fire rated Walls or floors, shall be approved by the concerned local authoritiesas similarly applicable to cable trays and Trunking.

### 1.03 RELATED WORKS SPECIFIED ELSEWHERE

| | | |
|---|---|---|
| A. | Section 16200 | Cables & Wires |
| B. | Section 16300 | Supporting Devices |

### 1.04 QUALITY ASSURANCE

A. Relevant British Standards
B. Concerned local authorities rules and regulations
C. Alternative codes and standards which will satisfy the engineer that the material offered is of equal standard to that specified.

### 1.05 SUBMISSION

A. Cut away samples with manufacturer's details.
B. Shop drawings of proposed conduit layouts

## PART 2 - PRODUCTS

### 2.01 STEEL CONDUITS (G.I Conduit)

Steel conduits shall be heavy gauge steel conduit hot dip galvanized inside and outside. The steel conduits, all junction boxes and other accessories shall be accordance with British Standard 4568 Parts 1 and 2 and shall be Class 4. The internal diameter of conduits shall be not less than 20mm.

All conduit boxes shall be constructed in malleable iron and in accordance with British Standard 31 Class B in the case of standard junctions or Class B5 where conduit is looped from point to point. All conduit work shall be so arranged to permit wiring to be drawn in after completion of conduit work. Where conduit work is concealed above suspended ceilings or in other building finishes the wiring shall be possible without disturbance to the building finishes. The conduit work at lighting points shall always be terminated in a standard or loop-in junction box and such boxes shall be firmly secured to enable the luminaire to be fixed to the lugs of the conduit box and be suspended therefrom without other support. Where conduits are terminated in a box without a screwed spout the junction shall be made by means of a coupling and an external thread brass bush with hexagon head.

In general, conduits shall be concealed within the building structure, behind suspended ceilings, within partitions, in floor screeds or plaster finishes. No conduit work shall be exposed on the surface unless this is specified or in services plant rooms. All external work shall be carried out using galvanized steel conduit and accessories. The installation shall be electrically and mechanically continuous throughout and where polyvinyl chloride conduit is utilized this shall be achieved by the use of a separate polyvinyl chloride insulated earth wire installed throughout the conduit run with terminations being made in conduit boxes or

metal enclosures of apparatus. All conduit ends shall be reamed to remove sharp edges and threads shall be of sufficient length to enable conduits to butt within couplings or to the stop end in box spouts. Draw-in boxes on straight runs shall be provided at not more than 9000mm centers. Where right angle bends are formed in the circuit, draw-in boxes shall be provided at not more than 7500mm centers and not more than two right angled bends shall be employed in any one run. Where conduit work is run external to the buildings a drain hole of 3mm diameter shall be drilled in the bottom of switch boxes and other low points to drain condensation. Conduits shall be fixed by means of spacing saddles on rough concrete or brickwork. On fair faced brickwork or plaster spacer-bar saddles may be used. Saddles shall be spaced at internals of not more than 1300mm on straight runs and not more than 200mm on either side of a bend or junction box. Fixings shall be made by means of galvanized steel wood screws of not less than 3mm diameter and 40mm in length, screwed into plastic or fibre insert plugs. All lighting point boxes, switch boxes or socket outlet boxes shall be fixed by means of two 8 gauge x 40mm steel screws.

## 2.02 PVC CONDUITS

**A.** All rigid PVC conduit and conduit fittings shall conform to British Standard 4607 are to be certified as suitable for use at ambient temperatures upto 55 Deg.C. Additionally, the material shall not soften or suffer any structural degradation at a temperature of 85 Deg.C and shall be non-hygroscopic and self extinguishing type.

All boxes and extension rings shall be fitted with brass inserts for the securing screws and with an earth terminal. Conduit fittings and accessories shall be of the same manufacture and shall be of the unthreaded type.

The internal and external surfaces of conduits shall be smooth and free from burrs and similar defects. The interior and ends of conduit fittings shall be free of sharp edges and corners and shall be smooth and well rounded to permit easy drawing in of cable and to prevent any damage to cable insulation.

Boxes in ceiling for lighting/fans etc. shall be of GI type.

All joints between conduits and fittings shall be watertight using vinyl cement recommended by the manufacturer of the conduit. A vinyl solvent shall be used for permanent joints and a cement of the type that shall remain in a sticky condition shall be used for expansion couplers.

A separate insulated earth wire shall be drawn into all PVC conduits.

The PVC conduits shall be installed generally in accordance with the requirements set out for metal conduits. Additionally the method of supporting PVC conduits shall allow for the longitudinal expansion and contraction of the conduit.

## 2.03 CONDUIT (FLEXIBLE CONNECTIONS)

**A.** Where conduit work has to be terminated with a flexible connection, as in the case of motors, the rigid conduit shall be terminated in a box adjacent to the motor and the connection between this box and the motor junction box made in flexible conduit. This shall be a corrosion resistant flexible metal tubing with a polyvinyl chloride sheath terminated at each end by a compression gland screwed into the connection boxes. An insulated stranded copper connection of section not less than that quoted in Table 54F of the I.E.E. Regulations shall be provided in each instance to ensure earth continuity.

## 2.04 CONDUIT (CAPACITY)

**A.** The number of polyvinyl chloride single core cables run in any one conduit shall be restricted in accordance with concerned local authorities Regulations (latest Edition).

Where three-phase circuits are run in conduit all three phases and the neutral of the circuit shall run in the same conduit.

## 2.05 METALLIC CONDUIT BOXES FOR EXTERIOR LOCATIONS

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.

## PART 3 – EXECUTION

**3.01** 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.

**3.02** 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.

**3.03** Except when embedded in concrete slab, all conduits shall be installed parallel to the lines of the building and at a minimum of 100mm 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.

**3.04** 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.

**3.05** 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.

**3.06** 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 concerned local authorities 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.

**3.07** Flexible conduits shall be used for connection of motors, HVAC equipment, recessed light fittings ...etc. Fixed conduits shall be terminated in a conduit box and flexible conduit shall then connect to the equipment.

**3.08** For flexible conduit on earth wire shall be wound around the flexible conduit and connected at each end to earth terminal.

**3.09** The conduit system shall, in general, be surface mounted in all plant rooms, electrical rooms and in Service Tunnel.

**3.10** The following general rules shall be adopted**.**

B. Conduit saddles shall be used at every 50 cms where the run is straight.
C. Saddles shall be used on both sides of a bend or coupling.

***** END OF SECTION *****

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# UNDERGROUND ELECTRICAL SERVICE

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Underground Electrical Services including, but not limited to the following:

1. Trenching and backfilling.
2. Manholes, hand holes and earth rod pits.
3. Cable warning signs and tapes.

### 1.02 RELATED SECTIONS

| | |
|---|---|
| 16000 | Electrical Works |
| 16010 | General Provisions for Electrical Work |
| 16110 | Raceways |
| 16120 | Conduits |
| 16200 | Cables and Wires |
| 16300 | Supporting Devices |
| 16400 | Main Distribution Equipment |
| 16500 | Lighting |
| 16640 | Earthing |
| 16670 | Lightning Protection system |
| 16720 | Fire Detection and Alarm System |
| 16760 | Data System |
| 16771 | Public Address /Evacuation System |

| | |
|---|---|
| 16772 | Audio Visual, Conference, Interpretation System |
| 16960 | Building Surveillance System (CCTV) |

## 1.03 REFERENCES

A. The IEE Wiring Regulations, 16th Edition (2001).

B. BS 4568 Rigid Steel Conduits, Zinc Coated.

C. BS 6099-2.2 / IEC 614-2-2 U.P.V.C. Rigid Conduits.

## 1.04 SUBMITTAL

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Name and address of agents stating whether any manufacturing or fabrication is carried out locally.
4. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
5. Technical performance of the equipment selected.
6. Dimensional details needed for installation and maintenance.
7. Delivery time from the date of orders.
8. Copies of test reports or certificates.
9. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

## 1.05 QUALITY ASSURANCE

A. All items for underground electrical services shall be as per manufacturer's standard construction and materials except civil works such as excavation, backfilling and concreting. Where this contradicts any part of the Specifications, the Contractor shall state so at the time of tender.

B. Manufacturers: Firms regularly engaged in the manufacture of such items of the types and sizes required, and whose products have been in satisfactory use in similar service for a period not less than 5 years. Preference shall be given to local manufacturers.

C. All work shall conform to applicable standards of Local Standards Organization and BS.

D. All underground electrical services for power and communications shall comply with the requirements and standards of Electricity Supply Authority and Telecom Supplier respectively.

## 1.06 DELIVERY, STORAGE AND HANDLING

A. During unloading of PVC pipes and other items for underground electrical services, rough handling shall be avoided. Chains or wire ropes may be used, provided they are suitably covered, to protect the pipes and other items from damage.

B. Unloading by mechanical means such as a crane or fork lift may be used where PVC pipes and other items for underground electrical services are delivered in bundles or in crates. However, consideration shall be given to the total weight and the lifting capacity of the mechanical equipment, and the observance of the statutory safety requirements.

C. PVC pipes and other items for underground electrical services shall not be dropped or thrown to the ground, knocked against other conduits or against sharp objects that any cause permanent damage.

D. In preparing for laying the pipes in trenches, the pipes and fittings may be unloaded along the trench direct from the back of a truck. Ducts and fittings should be unloaded on the side opposite to backfill. Fittings including end bells, couplings and other accessories such as solvent cement and lubricant shall be stored at the trench site under cover to prevent loss or damage.

E. When storing on site, PVC pipes and other similar items shall be placed a level surface and shall be supported to minimize distortion, and protected from direct sunlight. Horizontal supports of adequate width shall be spaced not more than 1.5 m centre to centre beneath pipes to provide continuous and even support.

F. Vertical side supports shall be provided at 3 m spacing on rectangular stacks. The maximum free height of such stacks shall not exceed 1.5 m.

## PART 2 - PRODUCTS

### 2.01 GENERAL

A. Underground Electrical Services for power, lighting, low current systems, control cables and grounding shall comprise manholes and handholes interconnected via concrete encased PVC pipes, direct buried PVC pipes or cable trenching; all as shown on the Drawings and mentioned in the Specifications or required on site for proper installation and maintenance of electrical systems.

B. Any trenching, backfilling, compaction and general grading required for electrical works shall be carried out in accordance with the requirements given in civil works specs.

C. Any metal frames, covers, louvers, etc. related to the works described under this Section shall be carried out in accordance with the requirements given in civil works specs.

D. Any cast in place concrete related to underground electrical services described under this Section shall be carried out in accordance with Section 03300.

### 2.02 DUCT BANKS

A. Duct banks shall be either direct buried type or concrete encased type, as applicable and required on site.

B. Heavy duty rigid PVC conduits shall be used for direct buried or concrete encased underground duct systems. PVC conduits and fittings shall comply with the requirements of Section 16130

C. PVC conduit shall be suitable for a temperature range of 4 °C to 90 °C. Conduits within the duct bank shall be supported on plastic interlocking spacers, at intervals of approximately 2.4 m. A 25 mm minimum separation, edge to edge, shall be maintained, both horizontally and vertically, between the ducts.

D. All duct banks shall have a 75 mm concrete cover on the top, sides, and bottom of the PVC ducts. Anchorage shall be used to hold the ducts in place while pouring the concrete encasement.

E. Where the duct bank enters a building below ground level, the conduit shall terminate in an appropriate fitting. An end bell shall be used on conduits entering manholes.

F. After completion of the installation of cables in the duct bank, seal the ends of duct banks using special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 $^{o}$C, and shall not slump up to a temperature of 149 $^{o}$C. It shall not be harden significantly when exposed to air.

G. A run of conduit shall not contain more than the equivalent of four quarter bends. Bends in conduit shall be made without reducing the internal diameter of the conduit. The inside radius of the conduit bends shall not be less than one metre.

H. Matching end bells and plugs, constructed of high impact plastic, shall be provided through out the duct bank at the ends and in manholes.

I. Each length of conduit shall be provided with one standard coupling. Couplings shall have a center step to ensure proper seating. Joints shall be made with the solvent cement as recommended by the conduit manufacturer.

J. Concrete encasement shall be class C20 concrete with 13 mm maximum size aggregate for all duct banks. For warning purposes, a red dye shall be towelled into the top surface after pouring the concrete.

K. An expansion joint of 55 mm per 100 meters maximum shall be provided in the duct banks. Additionally, a construction joint shall be installed if pouring of concrete is commenced any time after initial set of adjacent concrete. Neither expansion nor construction joints shall be installed under a roadway.

L. For duct banks in stable soils, the soil below the duct bank shall be compacted to 90 % of maximum density to a minimum depth of 300 mm. A dewatering system shall be used to lower the water table below the final excavation depth to eliminate disturbance of in-situ soil densities.

## 2.03 STUB-UPS

A. Stubs-up for electrical equipment connections and other requirements shall consist of either 100 mm or 150 mm diameter hot double-dipped galvanized rigid steel conduit entirely encased in concrete.

B. Rigid steel conduits and bends for stub-ups shall comply with the requirements of Section 16130.

C. The bends for stub-ups shall be 90 degrees with a minimum radius of 1200 mm.

D. Bends for stub-ups shall serve as transition between PVC conduits embedded below grade and rigid steel conduit installed exposed on surface. Such bends shall be provided with a PVC steel coupling on one end and a threaded male or female adapter on the other end.

## 2.04 MANHOLES

A. Appropriate type and size of manholes shall be provided as shown on the Drawings or required on site in compliance with the requirements of Local Standards Organization, BS and Electricity supply authority or Telecom supplier regulations.

B. Manholes for communication and low current systems shall be constructed in accordance with the standard practice and requirements of Telecom Supplier. Regulations.

C. A sump pit shall be built into the base slab directly beneath the manhole opening to collect and retain any water present in the manhole. Periodic maintenance may be required since sump pumps will not be permanently installed.

D. The duct bank manhole/interface shall include an expansion joint to take up longitudinal movement due to expansion and construction of the duct bank. This joint shall also act as water stop to prevent water from seeping inside the manhole.

E. The exterior of the manhole shall be waterproofed, with a bituminous coating in accordance with Section 03300.

F. Each manhole shall have two cable pulling irons opposite each duct bank entrance.

G. Access to deep manholes shall be through a chimney. Permanent ladders or rungs shall be installed, if required by the Engineer on site or shown on the Drawings.

H. Manholes shall be provided with earth-rods and cable supports as per the requirements of Local Standards Organization, BS or Electricity supply Authority.

I. The frames and covers of all manholes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

## 2.05 HANDHOLES

A. Handholes may be formed either monolithically or built up to designed sizes by combining several concrete sections cast in various shapes and sizes.

B. Handholes shall be provided with cast iron covers, sumps, ground-rods, etc. as shown on drawings or required as per the requirements of Local Standards Organization, BS or other applicable standards. Section joints shall be grouted.

C. The frames and covers of all hand holes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

## 2.06 EARTH ROD PITS

A. Earth rods pits shall be provided for all earth rods in accordance with the requirements of Section 16640.

B. Earth rod pits shall be precast of either square or round section with cover.

C. The cover of earth rod pits shall have appropriate marking as approved by the site Engineer.

## 2.07 CONCRETE PADS

A. Concrete pads shall be provided for all pad mounted equipment.

B. Concrete pads shall be 150 mm high, unless otherwise indicated, complete with steel reinforcement and necessary bolts, anchors, etc. required for the proper installation of pad mounted equipment.

C. Structural calculations for concrete pads supporting heavy equipment shall be submitted for Engineer's approval before commencement of work on site.

## 2.08 CABLE WARNING SIGNS AND TAPES

A. Where cables are directly buried, cable warning signs shall be installed to minimize the likelihood of damage to the cables by excavation. These signs shall be suitable for mounting on a riser pole, substation fence or separate stakes to suit the installations.

B. Posts for cable warning signs shall be placed as close to the cable as practical, but not closer than 900 mm horizontally from the cable.

C. Cable warning tapes shall be provided in accordance with the requirements given in Section 16120. Tapes shall be placed at least 300 mm above the buried cables, and shall cover full width of the cable trench.

# PART 3 - EXECUTION

## 3.01 INSPECTION

A. Establish and propose exact routes and requirements of underground electrical services for approval of the Engineer, after co-ordination with all other existing or new underground services, before commencement of the work on site.

B. Examine the areas and conditions under which the underground electrical services are to be installed, and correct any unsatisfactory conditions detrimental to the proper and timely completion of the work. The Contractor shall not proceed with the work until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

## 3.02 EXCAVATION AND BACKFILLING

A. Before commencement of the excavation, check the presence of any existing underground service by means of appropriate tools and equipment. The Contractor shall be penalized for damaging of any existing services in accordance with the rules and regulations set forth by the Owner and described in Section 16050.

B. Carry out excavation and backfilling in accordance with the requirements of civil works

## 3.03 DUCT BANKS INSTALLATION

A. The direct buried PVC ducts shall have a minimum dry sand cushion of 150 mm and a minimum dry sand cover of 300 mm, over which 50 mm thick concrete tiles shall be placed.

B. Depth for direct buried PVC ducts and PVC coated rigid steel conduits shall not be less than 600 mm from finished grade level to the top of conduits.

C. Top of concrete encased duct banks shall be installed 600 mm minimum below finished grade and shall connect manholes and handholes as shown and required on site. Where a duct bank connects to a building, adapt the duct bank, at one meter beyond the building exterior wall, to the building conduit with the required couplings.

D. The concrete encasement surrounding the duct bank shall be rectangular in cross-section, having a minimum concrete thickness of 75 mm beyond any surface of the conduit. Interlocking spacers shall be used to secure a uniform spacing between conduits of not less than 75 mm.

E. Trenches and duct banks shall be graded so that conduits will have a fall of at least 75 mm per 30 m towards the lower manholes or from the high point of the section towards the manholes or from the building towards a manhole.

F. Changes in direction of duct bank runs shall be accomplished by using special couplings limited to 5 degrees and/or 45 degrees bends having a 1 m radius sweep with straight sections of ducts between changes of direction and `S' sweep sections having a minimum of 500 m offset.

G. Where duct bank enters manholes, conduits shall terminate in end bells. Clean each conduit thoroughly before laying. During construction and after completion of the duct banks, plug the ends of conduits to prevent water washing mud into the conduits. Take particular care to keep the conduits clean of concrete or any other substance during the course of construction.

H. Securely anchor duct and brace with intermediate and base plastic spacers to prevent movement during the placement of concrete.

K. After the completion of portion of duct bank, a mandrel not less than 300 mm long, with a diameter of approximately 6 mm less than the inside nominal diameter of the conduits shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through to make certain that no particles of earth, sand or gravel have been left in the line. This cleaning shall be done one day after the concrete has been poured.

L. Install a nylon rope in each conduit after cleaning, after which the conduits shall be capped/plugged immediately.

M. All duct banks shall enter manholes through rectangular openings of suitable dimensions provided in walls. Such holes shall be sized to properly receive the duct, but shall not be too large for proper caulking. The space between duct banks and manhole walls shall be caulked tight with lead wool.

## 3.04 STUB-UPS INSTALLATION

A. Comply with relevant requirement of Section 16130.

B. Exact stub-ups locations and termination requirements for each equipment shall be verified on site, before commencement of laying underground or under floor PVC conduits for required power and control wiring.

C. Where extensions of PVC conduits above grade are required as stub-ups, a transition bend having PVC/Steel coupling on one end and threaded male or female adapter on the other end shall be used.

D. The PVC coated rigid steel transition bend or conduit shall extend minimum 150 mm above grade. A concrete envelope 100 mm high above the finished floor shall be formed around such risers to minimize corrosion at point of emergence. The top of the envelope shall be sloped for drainage.

## 3.05 CONSTRUCTION OF MANHOLES AND HANDHOLES

A. Manholes and handholes shall be constructed of precast or cast-in situ concrete to sizes shown on the Drawings. Horizontal concrete surfaces of floors shall have a smooth steel trowel finish.

B. Frames and covers shall be watertight and covers shall fit the frames without undue play. These shall be free from warp and blow holes that may impair their strength of appearance.

C. Steel and iron shall be formed to shape and size with sharp lines and angle and shall have a smooth finish.

D. Provide all necessary lugs and brackets.

E. Set pulling-in irons and other built-in items in place before pouring concrete.

F. Provide a 3 m earth rod external to each manhole and handhole. Also provide an earth bar in each manhole and handhole affixed to the wall above the duct bank box-outs. Connect to earth rod using 70 mm² bare copper conductor and bond earth conductors associated with each power cable inside the manhole or handhole.

## 3.06 CABLE WARNING SIGNS AND TAPES INSTALLATION

A. Direct buried cables shall be installed in accordance with the requirements for external cable installation given in Section 16120.

B. Cable warning signs shall mark all direct buried splices and shall be placed at intervals not exceeding 30 m along the cable route.

C. Cable warning tapes shall be installed 300 mm directly above cable throughout the entire cable route and shall cover the full width of cable trench.

***** END OF SECTION *****

# CABLES AND WIRES

## *PART 1 - GENERAL*

**1.01** All cables shall be designed for operation in systems where continuity of supply is the first consideration. They shall also be satisfactory in operation under the variations of current, voltage and frequency as may be met under fault and surge conditions on the system.

All materials shall be of the best quality and of the class most suitable for working under the particular condition of the systems. They must be capable of withstanding the normal variations of temperature and service conditions without disturbance or deterioration.

In general, cables and wires shall conform to the international standards and to the concerned local authorities Specifications.

**1.02 CONDUCTORS**

The conductors shall be high conductivity copper, stranded for power cables and solid for control cables' according to the type of insulation, the copper conductors will be plain or tinned.

**1.03** Cables shall be installed on cable trays or on building structure as indicated on the Drawings. They shall be neatly fixed in straight lines. On cable trays, cables shall be fixed by cable clips or ties while, on building structure cable cleats shall be used. The spacing of cable supports shall be as indicated in I.E.E. Regulations table B.2M. The minimum radius of bends for cables shall be in accordance with table B.1M of the regulations with bends made neatly and uniformly.

**1.04** Where single core cables are used for feeders, care shall be taken to ensure equal division of current among cables which shall be arranged in trefoil formation.

**1.05** Proper cable glands of non ferrous material shall be used for cable entries into distribution boards and equipment.

**1.06** Each end of each cable shall be provided with identification label lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, etc. and shall be made of durable material ensuring permanent legibility.

**1.07 STANDARDS**

Unless otherwise specified, cables wires and terminations shall comply with the following standards as appropriate :

**Cable and Wires**

| | | |
|---|---|---|
| BS 1442 | : | Galvanized Mild Steel wire for armouring cables. |
| BS 2897 | : | Aluminium strip armour for cables. |
| BS 6234 | : | Polyethene insulation and sheath for cables |
| BS 6360+IEC 228 | : | Copper conduct for cables |
| BS 6746+IEC 540 | : | PVC Insulation & Sheath for cables. |
| BS 6346+IEC 502 | : | PVC Insulated Cables |
| BS 5467+IEC 502 | : | Armoured Cables |
| BS 6004+IEC 227 | : | PVC Insulated Cables for Power and Lighting |
| BS 6500+IEC 227 | : | Insulated Flexible Cords |
| BS 6207+IEC 245 | : | Mineral Insulated Cables |

**Cable Termination**

| | | |
|---|---|---|
| BS 4579 | : | Performance of Mechanical and Compression Joints for Cables |
| BS 6081 | : | Termination of MICC Cables |
| BS 6121 | : | Mechanical Cable Glands. |

All cable terminations shall comply with the concerned local authorities requirements.

## 1.08 TESTS

- The cables shall be factory tested in accordance with the applicable standards, codes or recommendations.

- For each cable type, the following test certificates, providing tests have been carried out shall be submitted to the Engineer for approval.

- Mechanical properties of insulation and sheathing components.

- Resistance to cracking.

- Pressure test at high temperature.

- Resistance to flame propagation.

Final tests shall be made at site and the following routine tests will be carried out :

- Conductor resistance test.

- Insulation resistance.

## 1.09 RELATED SECTIONS

| | | |
|---|---|---|
| **A.** | Section 16120 | Conduits |
| **B.** | Section 16110 | Raceways |
| **C.** | Section 16300 | Supporting Devices |

## 1.10 SUBMITTALS

**A.** Provide product data for each type of cable.
**B.** Shop floor drawings showing cable routes and method of laying, spacing and space factor applied.
**C.** Submit cable assembly from each reel /drum.
**D.** Provide samples of cable markers, cable ties etc

## PART 2 - PRODUCT

### 2.01 PVC INSULATED/PVC SHEATHED CABLES

These shall be 600/1000V, single or 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 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 6746 C. Armoured sheathed cables shall have a single layer of galvanized steel wires for multi-core cables and aluminium wire or tape for single core cables.

### 2.02 CROSSED LINKED POLYETHYLENE CABLES

These shall be single core or multi-core cables, 600/1000V conforming to BS 5467 with high conductivity plain annealed stranded copper conductors to BS 6360, insulated with cross linked polyethylene (XLPE) to BS 6899 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 for multi-core cables and aluminium wire or tape for single core cables.

### 2.03 WIRES

**A.** Single core cables shall be plain annealed copper conductor to BS 6360, insulated with PVC to BS 6746, 600/1000 V grade conforming to BS 6004, single core for drawing inside conduits and trunking.

**B.** Single core cables shall be continuous from outlet to outlet and no splice shall be made except within outlet and junction boxes. A separate neutral wire shall be provided for each circuit. Wires shall be left sufficiently long to permit making final connections. The colour of insulation shall be as specified in IEE regulations for different phases, neutral and earth wires.

## 2.04 FLEXIBLE CORDS

Flexible cords shall be circular silicon rubber insulated glass fiber braided, three core 300/500 volts and shall comply with BS 6500. The conductors shall be tinned, annealed copper and the core shall be coloured Brown, Blue, Green/Yellow for identification.

## 2.05 MICC CABLING/WIRING

In all hazardous areas the cabling/wiring shall be done with MICC cables/wires. The decision of the engineer in respect of choosing such areas will be final and binding. Generally such areas are gas stores, areas handling medical gases, cold stores etc. MICC cables shall be to the following standards:

| | |
|---|---|
| **Flame Proof Barrier** | **BS 5345 Part 1** |
| Manufactured & Tested to | BS 6207 |
| Quality Assurance | BS 5750 |
| Cable Terminations | BS 6081 |
| **IEC Standards** | **IEC 702.1/IEC 702.2** |

## PART 3 - EXECUTION

### 3.1 GENERAL

Cables/wires shall be installed as per the concerned local authorities regulations. Where no concerned local authorities regulations exist IEE regulations shall be followed.

### 3.2 EXAMINATION

A. Verify that interior of the building has been protected from weather
B. Ensure that all raceways are thoroughly cleaned.
C. Verify that all construction works likely to damage wires /cables have been completed.

### 3.3 INSTALLATION

A. Use suitable wire /cable pulling lubricants.
B. Support cables above accessible ceiling. Do not rest cables on ceiling panels.
C. Use suitable rollers and pulling devices.
D. Perform field inspection and testing in the presence of the Engineer.
E. Verify all earth continuities.
F. Identify all circuits (Cables) with appropriate marking devices.

***** END OF SECTION *****

# SUPPORTING SERVICES

## PART 1 - GENERAL

### 1.01 VOLTAGE

All single phase devices shall be rated for 240/V 50 Hz and all three phase devices shall be rated for 415/V 50Hz.

### 1.02 DESCRIPTION

Provide wiring devices including switches receptacles, switchfuse units, junction boxes, control devices etc. as specified, indicated on drawings and as required for proper functioning.

### 1.03 RELATED WORKS SPECIFIED ELSEWHERE

| | | |
|---|---|---|
| A. | Section 16120 | Conduits |
| **B.** | Section 16110 | Raceways |
| **C.** | Section 16200 | Cables & Wire |

### 1.04 REFERENCE STANDARDS

| | |
|---|---|
| Lighting Switches | BS 3676 part 1/1989 & CENELECPREN60669-1 |
| Fuse Connecting unit | BS 1362 |
| 20A DP Switch | BS 3676 part1 |
| Switch Socket Outlet | BS 1363/1984 |
| *Flux Outlets* | *BS 5733/1995* |
| Dimmer light Switches | IEC 669-2-1,BSEN 50082-1 |
| Cooker Control Unit | BS 4177/1992 |

| | |
|---|---|
| Metal Clad Boxes | BS 5733 |
| Weather Proof Socket outlets | BS 1363/1984 |
| Sentry Socket outlet | BS 7288/199 |

Where No reference Standard is mentioned the applicable BS standard shall apply

## PART 2 - PRODUCTS

### 2.01 SOCKETS

**A.** Sockets shall be 250V, three pin, 16A switched type to BS 1363. Safety shutters shall cover pin holes to prevent accidental contact. Contact arrangement shall be such that contact is made on two sides of the rectangular pins of plugs.

**B.** UPS Socket outlets should be differentiated from the normal supply socket outlets by color (RED).

**C.** Sockets shall be fixed inside galvanized stamped steel boxes which shall be flush mounted in walls.

**D.** Pedestal mounted floor outlets shall be provided in locations where no wall or column is available

**E.** Sockets shall have White moulded cover plates as approved by the engineer The mounting heights for wall sockets shall be 300mm above finished floor level unless otherwise indicated on the Drawings.

**F.** Three phase sockets shall be of 5 pin design (3 phase + neutral + earth) as per the concerned local authorities Specifications. The current rating shall be as shown on drawings. All housing parts shall be pressure die cast in zinc base alloy and finished in hammered gray stove enamel; cable grips on the plugs shall have a rubber compression ring. The weather tightness shall be ensured by the rubber gaskets between plug and socket. Socket shall be provided with a screw-on cap. Plug top shall be provided with each socket.

**G.** Sockets working on normal plus emergency supply shall be provided with neon indicator which will remain illuminated even in off position.

**I**. Weatherproof sockets outlets shall have the weather tightness as mentioned in paragraph `E' above and shall comply with the concerned local authorities Specifications.

**J.** Terminal shall be grouped in-line with terminal screws backed out and terminals shall be marked.

## 2.02 JUNCTION BOXES

The junction boxes shall be DP 250V or TP 415 with current rating as shown on drawings or indicated in schedules. DP or TP switch controlling Junction Box shall

be provided with neon lamp. Floor mounted J.B. shall be of water tight design as required by the particular equipment being fed through the J.B.

Indoor Wall mounted Junction box and its associated switch shall White moulded & provided with flex outlet.

## 2.03 SWITCHES

**A.** Switches shall be of minimum 10A ratings unless higher ratings are shown on drawings.

**B.** Switches shall generally be flush mounted and of grid type at a height of 1200mm above finished floor level, unless otherwise indicated on the Drawings. Switches shall be White moulded cover plates as required by the engineer. Wiring terminals shall be of the screw type or solder-less pressure type having suitable conductor release arrangement. Where two or more switches are located in the same position, they shall be installed in one box and covered by a multi-gang cover plate.

**C.** Weatherproof switches shall have weather tightness as per Clause 2.01 (F) above.

**D.** Where Modular switches are employed the cover plate shall be manufactured in die cast metal with corners of square edged profile, and finished with a durable heat cured laccure. The Modular switches shall be 1 – 8 gang as indicated in drawings.

## 2.04 DIMMER SWITCH FOR FLUORESCENT TUBULAR LAMP

Remote control potentiometer unit shall be used for electronic dimmable ballast shall be used. It shall have a rotary switch for 'ON\OFF' function and a control voltage range with "MAX" and "MIN" trimmings.

## 2.05 FUSED SWITCHED OUTLETS (If needed for any particular equipment)

These outlets shall be to BS 4662 and provided with fuse links to BS 646 or BS 1361 or BS 1362 complete as required.

## 2.06 MOUNTING BOXES

Mounting boxes shall be 1 gang or 2 gang as specified and shall be manufactured from hot dip galvanized steel. Each box shall have brass earth terminal fitted in base and shall include ample knockouts and adjustable lugs.

## 2.07 DOUBLE POLE SWITCHES

The double pole switches shall be with indication neon lamps and shall be rated 20 amps unless otherwise mentioned. The face plate shall as per the concerned local authorities Specification G.3.2 and G.3.3.

## 2.08 SPARKLESS SOCKET OUTLETS

All outlets shall conform to degree of protection as applicable to non sparking equipment.

## 2.09 SPARKLESS SWITCHES

**All such switches shall conform to degree of protection as applicable to non** sparking equipment.

## 2.10 JUNCTION & SERVICE BOXES

The Junction & Floor Service boxes shall be supplied by the system supplier namely the Under Floor trunking or the Cast-in situ system as the case may be.

## 2.11 UPVC TRUNKING

Where Skirting & dado application are involved UPVC trunking of elegant profile shall be used. The system shall be capable of accepting wide range of components offering wide range of configurations. It shall be possible to use flat tees or angles & various type of adapters to navigate.

The trunking system shall be manufactured with requirements of BS 4678: Part 4 & BS 4662. Copies of test certificates shall be provided by the suppliers.

## 2.12 ISOLATORS AND SWITCH FUSES

**A.** Isolators and switch fuses, where mounted individually shall be of sheet steel/ Polycarbonate construction with /without doors and front operated handles. They shall be of the quick make, quick break type with removable shields over the fixed contacts, door interlocks and 'ON/OFF' indicators.

**B.** Isolators and switch fuses shall be single or triple pole with neutral, of ratings as indicated on the Drawings and provided with earth terminals. They shall be in accordance with IEC 408. The switch fuses shall be suitable for H.R.C. type fuses of Class Q1 to B.S. 88.

**C.** All outdoor isolators and switch fuses shall be in weather proof enclosures.

# PART 3 - EXECUTION

## 3.1 MOUNTING HEIGHT

A. All devices shall be installed at levels as per the concerned local authorities regulations.

B. Where Outlets feed particular piece of equipment then these shall be installed as per equipment manufacturer/supplier's requirements.

C. Where no data is available regarding the outlet for the equipment, it shall be installed at the level given by the engineer. As a guide line generally switches shall be mounted at 1350mm above finished floor level and sockets shall be fixed at 300mm above finished floor level unless

otherwise required for specified uses e.g. Above bench or near the equipment etc.

## 3.2 FIXING

A. Fix outlet boxes securely

B. Fix exposed outlet boxes to permanent inserts or lead anchors with machine screws.

## 3.3 LIGHTING SWITCHES

Locate at the strike side of the door.

## 3.4 PULL BOXES /JUNCTION BOXES

A. Fix pull boxes at minimum 10 Meter spacing and to limit the number of bends in conduit to not more than two 90 deg. Bends

B. Locate junction boxes as inconspicuously as possible but accessible after work is completed.

## 3.5 SPARES

Contractor / supplier shall provide 2 % of all supporting devices to the client for future use before certificate of completion of the project.

***** END OF SECTION *****

# MAIN DISTRIBUTION EQUIPMENT

## PART 1 – GENERAL

### 1.01 DESCRIPTION

**A.** The main distribution equipment shall comprise main low tension switch boards, switching metering panels, main and sub-main switch boards, distribution boards, isolators, switch fuses ...etc.

**B.** The supply and distribution arrangement shall be as indicated on schematic diagrams in the Drawings.

**C.** The equipment shall be assembled and tested in the factory of the approved local panel builder/manufacturer. Where any equipment need to be assembled at site, a prior approval of the engineer would be necessary.

**D.** Before placing any order for the supply of equipment, it shall be ensured that the physical sizes of equipment when installed shall not infringe any clearance required by the concerned local authorities regulations. Where no such regulation is available IEEE regulations shall be applied.

**E.** The contractual responsibility for the supply and installation shall be as indicated on drawings.

### 1.02 REFERENCE STANDARDS

Switchboards and Motor Control Centers shall comply with the following as appropriate. Where no regulation / standards are mentioned latest IEC standards shall be applicable.

| | |
|---|---|
| BS 88 | Cartridge Fuses |
| BS142 (Latest) | Electrical Protective Relays |
| BS 159 | Bus bar & Connections |
| BS 162 | Electrical Power Switchgear |
| BS 3938 IEC 185 | Current Transformers |
| BS 4794 IEC 337-2 | Control Devices |
| BS 5685 | Electricity Meters General |
| BS 89 IEC 51 | Direct Acting Indicating Electrical Measuring Inst. |
| BS 5685 IEC 521 | Electric Meters |
| BS 5420 IEC 144 | Degree of Protection of enclosures |
| BS 4752 IEC 947-2 | Switchgear & Control Gear |
| IEC 947-4 | Contactors |

| | |
|---|---|
| IEC 947 (Part 1-7) | Low Voltage Switchgear & Control Gear |
| IEC 439 (Part 1-4) | Low voltage Switchgear & control gear assemblies |

## 1.03 RELATED WORKS

| | |
|---|---|
| Section 16110 | Raceways |
| Section 16120 | Conduits |
| Section 16200 | Cables and Wires |
| Section 16300 | Supporting devices |
| Section 16620 | Diesel Generator |
| Section 16635 | Earthing |

## 1.04 SUBMISSION

### A. Shop Drawings

Submit dimensional shop drawings including sections and elevations and showing positions of major components position and method of fixing and terminating cables.

### B. Project Data

Submit full specifications of the enclosure and the components of the switchgear and switchboards and panels.

# PART 2 - PRODUCT

## 2.01 MAIN LOW TENSION PANEL BOARDS

**A.** The main low tension switch boards shall be of indoor construction, dead front, metal enclosed free standing, dust and vermin protected, front operated and of clean and modern appearance.

**B.** The switchboards shall be assembled and coordinated by one manufacturer and shall be constructed in accordance with B.S. 5486 : part 1.1977/IEC 439.

**C.** The panel shall be of the cellular cubical type class 2CC FBA and shall be of the folded sheet steel construction fabricated out of electro galvanized cold rolled sheets of minimum 2mm thickness for body and frame work and not less than 1.5mm for doors and cover plates.

**D.** The panels, after fabrication, shall be thoroughly cleaned in a vapor degreasing tank to remove all traces of oil and wax and provided with a coat of electrostatic, polyester powder coating, light grey colour, shade No. 10A03 to BS 4800.

**E.** All doors and removable cover plates shall be provided with neoprene gasket so as to obtain degree of protection IP53 to IEC 144.

**F.** Each outgoing breaker shall be enclosed in its own compartment (cell) fitted with a hinged door interlocked with the operating handle in such a way that:

1. It shall be possible to open the door only when the handle is in 'OFF' position.
2. It shall not be possible to switch the unit 'ON' when the door is open.

Moreover, no live parts shall be exposed when the compartment door is open.

**G.** Protection against shock shall be provided in accordance with the requirement of BS 5486 Part 1.

**H.** The switchboard shall be of the rear access pattern and vertical cable way shall be provided in each section of the switchboard. The cable way shall be provided with bolt-on covers. All terminals in the cable way shall be fully shrouded to prevent accidental contact when the covers are removed.

**J.** All external bolts or screw heads shall be chrome or cadmium plated.

**K.** The equipment in the switchboard shall be accessible with indicating instruments mounted not higher than 1.8m. And the centerlines of operating devices not higher than 1.8m. Above switchboard base. The switchboard shall be properly fixed to the floor with foundation bolts grouted in the floor or bolted to channels laid across the cable trench.

**L.** The switchboards shall have top or bottom cable entry as required. Basically, main incoming cables shall be bottom entry and outgoing cables top entry.

**M.** The switch boards shall contain the air circuit breakers, bus bars, bus couplers, MCCBs, instruments, earth bus, ...etc. as specified here under and as per drawings with ratings and arrangement as shown on the Drawings and shall be complete with all internal wiring and connections.

**N.** The switch boards shall be tested at the manufacturer's premises as well as commissioned after installation in accordance with tests stipulated in IEC 439.

**O.** Additionally, Main Low Tension Switch Board shall comply with the concerned local authority's requirements.

## 2.02 BUSBARS

**A.** The switchboard shall be provided with fully rated Bus bars for the entire width of the board. In addition, each section or panel of the switchboard shall be provided with vertical busbars of adequate rating to provide branch connections to the outgoing breakers.

**B.** The horizontal and vertical bus bars and connection shall be fully segregated such that these shall not be accessible when the compartment doors and cable way covers are opened. They shall be provided with barriers which are removable by tool or special key.

**C.** The bus bars shall be made of electrolytic, hard drawn high conductivity flat pure tinned copper bars complying with IEC Standard. The whole bus bar system shall comply fully with the requirement of latest IEC standards.

**D.** The bus bars shall be air insulated and shall be rigidly supported on purpose made insulators of non-hygroscopic glass fiber moldings having a tracking index of not less than 600.

**E.** The Main Low Tension Panels (MLTPs) busbar together with its connections to the incoming and outgoing unit shall be suitable to withstand a short circuit of 50,000 sym. amperes and in all other cases; it shall be suitable for the fault level at that point.

The bus bars shall be provided with colored PVC sleevings at regular intervals for phase identification. Painted bus bars may be acceptable in special cases when panels are manufactured/assembled in Jordan.

## 2.03 AIR CIRCUIT BREAKERS

**A.** The air circuit breakers shall be of the air break trip free draw out type with the main contacts encased in a reinforced polyester casing and offer double insulation from the operators on the breaker front face. The air circuit breaker shall be fully tropicalized (T2) as defined in IEC 68.2.30 and shall have salt spray resistance as per IEC 68.2.11. The ACB shall comply with IEC 947.2 utilization category B with Ics=Icu=Icw and shall accept reverse feeding without reduction of performance. The ACB shall comply with the isolating function requirements of IEC 947.2 section 7.1.2 and shall have minimum 500 V 50Hz operational voltage, 1000 V 50 Hz rated insulation voltage and 8kV withstand surge voltage (Vimp). The 3-pole and 4-pole versions shall have ratings as shown in the drawings. In the 4 pole version the neutral pole shall have the same current rating as the other poles from 800 to 4000A . The breaking capacities shall not be less than 50 kA symmetrical for 1 sec. at 415 volt. Evidence of the service breaking capacity (Ics) shall be produced by test certificates from one of the internationally recognized testing Laboratories. (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

**B.** Unless otherwise mentioned the ACB shall be of the O-C-O stored energy spring type with a closing time less than or equal to 80 millisecond. Electrically operated circuit breakers shall have the spring charging motor connected so that the springs remain charged always with the motor disconnected after charging. The spring charging time shall not exceed 4 seconds. A standby manual operating handle for spring charging shall be provided for operating the circuit breaker in case of power or motor failure. Antipumping shall be provided by integral devices to prevent reclosing after a close-open operation if the closing impulse is maintained after the breaker has opened. External relays are not acceptable

**C**. The circuit breaker shall have three positions of the drawout mechanism, namely service position where all main and auxiliary contacts are made, test position where main contacts are open but auxiliary contacts are closed and isolated position where all contacts are open. Mechanical indication on the front of the ACB shall be provided to indicate

A) Main Contacts Closed ‘On’,

B) Main Contacts Open 'Off',
C) Springs Charged,
D) Springs Discharged
E) Service Position,
F) Test Position, And
G) Isolated Position For Drawout Mechanism.

**D.** Any attempt to withdraw or insert the breaker when it is 'ON' shall trip the breaker automatically. An interlocking shall be provided to prevent insertion of a circuit breaker having a rating higher than the current rating of the ACB cradle.

**E.** Insulated safety shutters shall screen all live parts in the ACB cradle when the breaker is in the isolated or racked out position.

**F**. The moving contacts comprising the main and arcing contacts shall have visual wear indicator and be of the spring loaded type. The main contacts and clusters shall be site replaceable. The electrical endurance shall not be less than 4000 operations for rating up to 3200A and not less than 2000 operations for ratings above.

**G.** The circuit breakers shall have sufficient number of auxiliary contacts for interlocking system as indicated and described on the drawings and for interfacing with building automation system (BAS), with two spare sets of normally open and normally closed contacts. It shall be possible to connect all auxiliary wiring from the front face of the air circuit breakers and this wiring shall be taken through a set of disconnecting contacts, so that all auxiliary wirings are automatically disconnected in the isolated and drawout positions.

H. The circuit breakers shall be equipped with MCR, overcurrent and earth leakage protections by means of integral self-powered microprocessor based solid state RMS sensing current relays. The long time overcurrent protection shall have a setting range between 40 and 100 per cent of sensor rating in steps of 2 per cent. The corresponding time delay shall be adjustable from 15 to 480 seconds The short time overcurrent protection shall have a setting range from 40 per cent to 15 times the sensor rating. The corresponding time delay shall be adjustable from 15 seconds. The sort times the sensor rating. The corresponding time delay be adjustable from instantaneous to 400 milliseconds with the possibility select time inverse characteristic for improved discrimination. Instantaneous

overcurrent protection shall be adjustable from 2 times the current up to the circuit breaker electrodynamical withstand. The earth protection shall have current settings from 10 per cent of the rated current 1200 A in steps of 10 per cent. The time delay setting shall be variable 100 millisecond to 400 millisec in steps of 100 millisec.

J. The RMS value of the phase currents and interrupted current values shall be displayed on the built-in digital ammeter and the LED's shall indicate the type of fault on the front face of the trip unit. An indicator shall give indication of the main contact wear according to the number of operations and the values of the switched currents. A bar graph shall display the load indication of each phase and the highest value of phase currents shall be stored and displayed on demand. Trip unit malfunction or internal overheating shall be indicated by a self monitoring alarm.(Some features may differ from one manufacturer to another)

**K.** The air circuit breaker used on bus-section shall be identical to Air Circuit Breaker specified but with only the Making Current Release (MCR) protections and instruments specified but with the following indications :

1. Circuit breaker closed.
2. Circuit breaker open.
3. Circuit breaker tripped.

**L.** The main low tension panels shall be provided with cable boxes to suit the incoming cables from the transformer which are supplied and installed by the concerned local authorities.

## 2.04 CURRENT TRANSFORMERS

Current transformers shall be of Class C accuracy for indication and Class CM accuracy for metering purpose. The secondary windings shall be rated at 5A and the rated output shall be suitable for the burden.

## 2.05 INSTRUMENTS

**A.** The measuring instruments shall include ammeter voltmeters, maximum demand indicators and selector switches as indicated on the Drawings.

**B.** The instruments shall have anti-glare glass fronts, anti-parallax scales and white faces with black numerals and markings. The instrument cases shall

be semi-flush mounted and shall be approximately 100 x 100mm square. Accuracy shall be one percent of full scale values. Moving elements shall be provided with zero adjustments external to the cases.

**C.** Ammeters shall be moving iron type, to B.S. 89 scaled 0-2000 A for main incoming supply.

**D.** Voltmeter shall be moving iron type to B.S. 89 scaled 0-500V and provided with 6-position selector switches allowing reading of line to line and line to neutral voltages.

**E.** Maximum demand indicators shall be of the thermal type with a 15-minute time delay.

## 2.06 kWh METERS

**A.** The kWh Meters for the concerned local authorities shall be suitable for operation on 415/240 volts, 3 phase, 4 wire, 50 Hz supply.

**B.** The meter shall be absolutely dust and vermin proof, protected from corrosion due to high humidity and compensated against the effect of temperature upto 55 Deg.·C.

**C.** The Meters shall maintain their accuracy over many years service under Jordan climatic conditions. The counters shall be of the cycle-meter type with six digits and shall give a direct reading of power consumption to six figures, the lowest figure being units and not tenth of units. Pointer type counters are not acceptable.

**D.** Multiplying factors shall not be used except for the larger size of current-transformer operated meter, where 10 and 100 may be used. The calibrating adjustments shall be operated by screw-driver only.

**E.** The Meter cover and cases shall be of metal and not plastic.

**F.** The ratings for direct connected whole current meters shall be 50, 75 and 125 amperes maximum per phase and the terminal holes shall not be less than 6,9 or 12mm. diameter respectively.

**K.** Higher ratings meters shall have not less than 5mm. diameter terminal holes and shall be operate through current transformers with 5 amperes

rating to the secondary side and the counter or the meter shall be calibrated to read the primary Kwh passing through the current transformers.

**L.** The current transformers shall be of the ring or slide on busbar type.

**M.** Three current transformers of 2000/5A shall be provided for each meter.

**N.** All meters shall be handed over to the concerned local authorities for Calibration before final erection and connection.

## 2.07 FUSE SWITCHES

**A.** Fuse switches shall fully comply with BS 5419 : 1977, IEC 408 : 1972 meeting all of the concerned local authorities requirements.

## 2.08 MOULDED CASE CIRCUIT BREAKERS

**A.** The moulded case circuit breakers shall comply with IEC 947-1 and IEC 947-2 standards and shall be of the quick make and quick break type having free toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually. They shall be of utilization category 'A' having rated service breaking capacity (Ics) as indicated in the drawings. The circuit breakers shall be suitable for isolation as per IEC 947-2 and shall have rated operation voltage of 500V 50 Hz, insulation voltage of 750 V, 50 Hz. The breaker shall be available in 3 or 4 pole version as per the drawing. All poles shall operate simultaneously for circuit breaker opening, closing and tripping. The mechanism shall be completely enclosed in the compact moulded bakelite case. The moulded case circuit breaker shall provide class II insulation (according to IEC 664) between the front and internal power circuits. The breaker shall be designed for both vertical and horizontal mounting and it shall be possible to supply power either from the upstream or downstream side without any adverse effects on the electrical performance. Evidence of the service breaking capacity (Ics) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

**B.** Breakers contacts shall be made of non-welding and non-corrodible composition. Circuit breakers shall be actuated by a toggle or handle that

clearly indicates the three positions 'ON', 'OFF' and 'TRIP' thus indicating clearly abnormal conditions of the circuit. In order to ensure suitability for isolation complying with IEC-947-2, the operating mechanism shall be designed such that the toggle or handle can only be in OFF position if the power contacts are all actually separated. The molded case circuit breakers shall be able to receive a locking device in the "isolated" position and there shall be a "push to trip" button in front to test operation and the opening of the poles. The circuit breaker rating, the 'push to trip' button, outgoing circuit identification and the contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard. Single pole breaker with handle tie or bar equivalent construction are not acceptable for a multi-pole breaker. Molded case circuit breakers shall be the fixed type. Plug in type breaker connections are not acceptable.

**C.** Breakers shall have the rating and rated service breaking capacity (Ics) as per IEC 947-2 as indicated in the drawings. The breakers shall be of current limiting type. For short circuits, the maximum thermal stress $I^2t$ shall be limited to $10^6$ $A^2s$ for ratings up to 250A and $5 \times 10^6$ $A^2$ s for ratings above up to 630A.

**D.** Circuit breakers shall have inverse time tripping characteristic with automatic release secured through action of a combination of thermal-magnetic or electronic trip units which shall trip free of the handle and operate in response to an overload or a short circuit.

**D.** It shall be possible to equip the moulded case circuit breaker with a motor mechanism if needed and closing of mechanism shall take place in less than 80 ms. The operating mechanism shall be of the stored energy type only. The addition of motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics and shall not block device settings.

**E.** The MCCB's shall be designed for adding auxiliary contacts such as shunt or undervoltage releases after installation at site. The auxiliaries shall be separated from power circuits. It shall be possible to install auxiliary switches for fault/status indication in already energized MCCB without the need to trip the MCCB.

**G.** It shall be possible to assemble earth fault protection of MCCB's by adding a residual current device directly to the circuit breaker case and it shall operate without an auxiliary power supply. The add on RCD's shall

comply with appendix B of IEC 947-2 standard. They shall be immunised against nuisance tripping as per IEC 255 and IEC 801-2 to 801-5 standards

**H.** MCCB with ratings upto 250A shall be equipped with thermal magnetic or electronic trip units which are fully interchangeable types. The breakers with ratings over 250A shall be equipped with electronic trip units which shall remain operational for ambient temperatures upto 60°C. Electronic trip units shall comply with appendix F of IEC 947-2 standard. It shall be possible to fit lead seals to prevent unauthorized access to the settings of the electronic and thermal magnetic trip units.
MCCB's equipped with thermal magnetic trip units shall have adjustable thermal protection and fixed magnetic protection for current ratings upto 160A. For current ratings greater than 160A the thermal magnetic trip units shall be adjustable from 5 to 10 times the current rating. In four pole breakers the neutral pole shall have the tripping threshold equal to that of the phases unless otherwise stated in the drawings.

**K.** MCCB's upto 250A frame size equipped with electronic trip units shall sense the actual RMS values for:
a) long time protection from 40% to 100% of the trip unit rating,
b) the short time protection shall be adjustable from 2 to 10 times the thermal setting,
c) the instantaneous protection shall have the threshold fixed between 12 and 19 times nominal current, depending on the rating.

**L.** MCCB's over 250A up to 630A frame size shall be equipped with electronic trip units shall sense the actual RMS values for: : a) long time protection from 40% to 100% of the trip unit rating, b) the short time protection shall be adjustable from 2 to 10 times the thermal setting, c) the instantaneous protection threshold shall be adjustable from 1.5 to 11 times nominal current and d) a thermal memory (in the event of repeated overloads, the electronic trip units shall optimize protection of cables and downstream devices by memorizing temperature variations). A load monitoring function shall be an integral part of the electronic trip units indicating four load levels (60%, 75%, 90% and 105%) by LED's (with flashing LED for 105%). It shall be possible to install with the electronic trip unit a high threshold earth fault protection, load monitoring and LED's in front to indicate the cause of tripping. It shall be possible for the MCCB to communicate with Building Management System (BMS).

**M.** The following frame sizes shall be adopted for different breakers:

| | |
|---|---|
| upto 80A | 100/125A frame size |
| 100A to 160A | 250A frame size. |
| 250A to 350A | 400A frame size. |
| 350A and above | 630A frame size |

**N.** Each MCCB's shall have minimum 2 pairs of NO /NC auxiliary contacts

## 2.09 EARTH LEAKAGE RELAYS

### A. Earth Fault Relay

a. The relays shall comply with IEC 755
b. The relays shall be protected against nuisance tripping caused by switching surges or by lighting surges.
c. The relays shall be of solid state type (mechanical type shall not be accepted),self protected from high magnitude earthfaults and protected against dirt, vibration and moisture.
d. The relays shall be able to operate in the presence of fault currents with DC components.
e. Each relay shall accept a wide range of auxiliary supply voltages from 48V to 240V AC and 48V to 300V DC as per the requirement in the drawings.
f. The sensitivity of relays shall be adjustable as per the requirement in the drawings from 0.03A to onward. The relays shall have time delay option if required from instantaneous to 1 sec. using an 8 position switch.
g. The size of the relays shall be compact. They shall be suitable for mounting on symmetrical rail horizontally or vertically.
h. The relays shall be equipped with one changeover output contact. The continuity of the measurement circuit shall be monitored to ensure that the toroid circuit is not open.

### B. Current Sensors (Toroids)

a. Rectangular type for busduct feeders
b. Circular type for cable feeders
c. The range of associated toroidal transformer shall be of the closed type with an inside diameter of 30 to 200 mm.
d. To have cable guides to ensure that feeder cable is centered within the sensor.

e. The maximum link resistance from toroid to relay link must not exceed 3 ohms.
Current operated earth leakage relays shall be used either in conjunction with circuit breakers for tripping the breakers or for giving alarm signal only by an indicator lamp and alarm bell in cases of earth leakage.

## 2.10 EARTH BUS

The copper earth bus shall be minimum 50% of the phase conductor size extending throughout the length of the switch board and fixed to the steel members of the switch board. The earth bus shall be extended at the ends for connection to the earth electrodes and shall have provision for terminating earth continuity conductors.

## 2.11 MAIN AND SUB-MAIN DISTRIBUTION BOARDS

**A**. The main and sub-main distribution boards shall be totally enclosed, dust protected and factory fabricated suitable for operation on 415/240 V, 3 phase, 4 wire, 50 Hz supply.

**B.** Main and sub-main distribution boards shall comprise main incoming isolator, busbars, moulded case circuit breakers, earth leakage relays, earth bus etc. with ratings and arrangement as shown on the Drawings and all housed in a sheet steel panel fully rust-proofed and electro static powder coated paint; equipped with a hinder door with approved locking device.

**C.** The main isolator shall be a triple pole and neutral moulded case circuit breaker without tripping element.

**D.** The busbars shall be high conductivity copper bars to B.S. 159 with ratings as indicated on the Drawings for the three phases and neutral. The busbars shall be arranged and marked to the approval of the Engineer.

**E.** The moulded case circuit breakers and earth leakage relays shall be as specified in paragraph 2.08 and 2.09 above.

**F.** The rated service breaking capacity (ICS) of MCCBs shall be 50 KA for MLTP, 28KA for MDBE, 22 KA for MSBs and MCCs, 14 KA for SMSB and MCC fed from MSB unless indicated otherwise on the Drawings.

**G.** The earth bus shall have adequate rating and length for connecting the incoming and outgoing earth wires or tapes.

**H.** The distribution boards shall be complete with all necessary internal wiring and connections

**J.** High conductivity copper bars or rods covered by coloured PVC sleeving for phase identification shall be employed for connections of 200A and higher. For smaller connections PVC insulated cables to B.S. 6231 shall be used with coloured insulation for phase identification.

**K.** The arrangement of the boards shall be such that the main isolator and MCCBs can be operated when opening the door but to gain access to the MCCBs, cabling and terminations a second cover should be removed. There shall be ample clearance and ample space available inside the boards for cabling and terminations. Adequate clearance shall be maintained between phases and non-current carrying metal and terminals shall be so located that in the final connected positions there shall be no crowding of wires in close proximity of metal.

**L.** The boards shall be complete with cable glands for convenient terminations of incoming and outgoing cables. The cable glands shall be so fixed inside the board that ample clearance exists between various feeders.

## 2.12 M.C.B. DISTRIBUTION BOARDS

**A.** MCB distribution boards shall comprise of a totally enclosed dust and vermin protected, factory fabricated heavy gauge sheet steel enclosure of 2mm thickness and door of 1.5mm thickness and of ample size with a hinged door and approved fastening device. The enclosure shall contain an isolating switch, adequately rated busbars for phases, neutral connector blocks, earth terminal block and single or triple pole miniature circuit breakers with ratings and arrangement as shown on schedules. DB enclosures shall be suitable for 18 or 24 or 36 SPN ways, has the case may be. HRC fuses shall be provided in MCB Distribution Boards where fault level exceeds 6KA.

**B.** In corridors DBs enclosure shall be housed in electrical closets. All electrical closets shall be of the same size with architectural finishes as required.

**C**. All risers falling in areas like corridors or important rooms shall be provided with an hinged access door with finishes as required by architect.

**D.** The main isolating switch shall be of SPN or TPN air break design. Where indicated on the Drawings, the MCBs for the lighting circuits and socket outlet circuits shall be electrically separated by the provision of separate busbars and each section shall be protected by a separate current operated earth leakage circuit breaker. The RCCB shall afford earth leakage protection for the lighting and power sections. Fuses shall be provided for DBs wherever necessary and/or shown on drawings.

**E.** The neutral and earth terminal blocks should be provided with arrangement for connecting on each block one cable for each outgoing circuit and one incoming cable of size indicated on the Drawings. The wiring between the RCCB and busbars shall be carried out with coloured PVC insulated cables with copper conductors for phase identification. The arrangement of the enclosure shall be such that the MCBs and COELCB cannot be operated without opening the hinged door but to obtain access to MCBs and COELCB, it should be necessary to remove a second cover. Adequate clearance shall be maintained between phase and non-current carrying metals. Terminals shall be so located that in the final connected positions, there shall be no crowding of wires in close proximity of live metals.

**F.** MCBs shall be so arranged in the board that it shall be possible to replace a triple pole MCB with three adjacent single pole MCBs or vice versa. The board shall be flush mounted type unless indicated otherwise on the Drawings. Cable glands shall be provided where required.

**G. MCB**

MCB shall comply with EN60439-3 and shall be symmetrical rail mounted type available in one, two, three or four poles version. They shall be trip free type with quick make, quick break mechanism. The rated ultimate breaking capacity (Icu) of the MCB's shall be at least equal to the prospective fault level at the point of the distribution system where they are installed, unless cascaded with an upstream breaker. The minimum rated ultimate breaking capacity (Icu) of the MCB shall be 10 kA if not

mentioned on the drawings. MCB can be reverse fed without reduction in performance. Trip setting as indicated on the schedules of points. The MCB shall have thermal overload trip to accept 5% overload and to trip at 30% of rated current as per IEC 947-2. The instantaneous magnetic trip shall operate at 5 to 10 times the rated current for 1P, 2P, 3P or 4P breakers. It shall be possible to replace 3 single phase units with one 3 phase unit. The breakers shall be of current limiting type (DIN type**).** The quick lag type breakers (QL/plug in type) are not acceptable. Evidence of the ultimate breaking capacity (Icu) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

The operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. It shall be "automatic resetting type". The individual operating mechanism of each pole of a multi pole MCB shall be directly linked within the MCB casing and not by operating handles. The operating handle shall be of the toggle type with possibility of padlocking facility and rotary handle. Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection. Current discriminations tables shall be provided for each rating of the breaker. The terminals shall be of the tunnel type (IP 20) in order to minimize the risk of direct contact. It shall be possible to fit on site auxiliaries like shunt trip coil, undervoltage release, ON-OFF switch, alarm switch or residual current device 30 or 300 mA with remote tripping possibility.

The term 'rcb' /'rcbo' shall denote an mcb with built-in earth leakage protection.

## H. RESIDUAL CURRENT CIRCUIT BREAKER (RCCB)

RCCB shall comply with CEE 227 or IEC 1008 standards. The RCCB shall provide the functions of isolation, switching and earth leakage protection of electrical circuits.They shall have a residual current operated electromechanical release which operates without auxiliary source of supply to an earth leakage fault between active conductors and earth. RCCBs shall incorporate a filtering device preventing the risk of unwanted tripping due transient voltage. They shall provide a high degree of protection against earth faults, fire hazards and electric shock.

RCCBs shall be available in 2 and 4 pole versions with current ratings from 16A to 100A and an earth leakage trip rating as specified in the schedule of points. They shall be suitable for operation on 415V, 3 phase, 4 wire, 50 Hz supply. They shall have an operating temperature from -5 to + 60° C. RCCB shall have a trip indication on the front face by a red mark. It shall be possible to achieve vertical discriminations with RCCBs.

RCCB alone shall have a short circuit withstand capacity of 3 KA. RCCB must be protected with short circuit protective devices installed upstream inside the DB enclosure having appropriate fault level protection.

RCCB shall consist of the following mounted in a robust body of all insulated material:

- A current transformer
- A tripping coil with contact assembly
- Main supply contact
- On/Off switch
- A test button
- A trip free mechanism

Where a RCCB is used a s a separate item and not housed within a distribution or switchboard, it shall be housed in a dust protected enclosure to prevent accidental contact with live terminals.

**I.** Where contactors are shown in DBs, the distribution board shall deemed to be understood as a multiple section board.

**J.** All outdoor MCB distribution boards shall be in weatherproof enclosures.

**K.** The term RCB shall mean an MCB with built-in earth leakage protection similar to'Quickguard' of Square-D

**L CONTACORS**

The contactors shall conform to BS 775, IEC 947-4 suitable for Class II duty and having a making and breaking capacity in accordance with utilization category AC3.
Unless specially required otherwise the operating coil shall be rated for 240V 50Hz.
Contactors shall be rated for continuous duty.
Contactors not forming a part of Distribution Board shall be housed in a purpose made enclosure having appropriate IP rating suitable to the mounting location

### M PULSE RELAYS

Pulse relays shall be suitable AC or DC operation as per system manufacturer Normal practice. The operation voltage may be 240V 50Hz or 24V DC
The pulse relay shall be suitable for actuation manual through built-in Push button.

## 2.13 MOTOR PROTECTION

Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2

Co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range.

The specifications mentioned in the MCCB's section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device.

The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.

## 2.14 ELECTRONIC SOFT STARTERS

**Where these starters do not fall under the electrical sub-contractor's scope of work, the specifications may be used for all co-ordination works.**

The concerned factory manufacturing the equipment must be ISO 9001 certified for quality assurance and the product supplied shall bear the CE mark.

Contractor to provide complete coordination / selection table prepared by the soft starter manufacturer and indicating clearly the recommendation components such as fuses, breakers, contractors and overload relays so as to achieve Type – 2 coordination as per IEC guidelines. These components shall be from the same manufacturer for easy substitution and consistent operational reliability of the equipment. Mixing of brands is wholly unacceptable. The soft starters in general shall comply with the following.

**Enclosure**

- Equipment shall be manufactured in accordance with IEC regulations.
- The enclosure used shall be adequate per EMC and Low Voltage directives. The equipment shall be CE marked.
- Units above 20A shall be fitted with adequate forced air-cooling (fan-type).

**Control Circuit**

The soft starter shall comprise a uP – type control arrangement (PCB based) for triggering control and offer as a minimum, the following functions, selectable using DIP-switch or settable using potentiometers:

- Start Ramp (settable) for upto 60 sec.
- Stop Ramp (settable) for upto 240 sec.
- Startup Voltage (settable) 10 to 60%
- Stop Voltage (settable) 10 to 60% (for Pump Stops)
- Current limit during start (settable)
- Energy saving feature (selectable) for optimal power factor, current and efficiency levels on a real time basis, provided with activation delay (selectable).
- Kick start function for transient high-torque condition to overcome high initial inertia/friction loads (selectable)
- High Current Trip (selectable)

Status indications shall comprise as a minimum, LED display of the following:

- Fault (internal)
- Phase Loss
- Overload
- Ready
- Running
- Ramp-up complete
- Energy Saving function active (if selected)

Further as a minimum, the following volts-free signals shall be made available:

- Fault
- Overload
- Ramp-up complete

**Power circuit**

The following features shall be provided as standard:

- Start and stop ramp to be achieved using reduced voltage triggering of thyristors connected in antiparallel, with each phase individually double-protected by adequate snubber circuits and varistors to withstand 4kV at 2.5Hz for 60 seconds or more.
- Diode-thyristor paralleling in unacceptable.
- Starter shall be suitable for continuous duty. Further, the circuit must be suitable for constant mains voltage, even when starter is not in use.
- Electronic overload relay to be provided as option in all ratings above 30A and as standard feature for heavy-duty applications to protect the unit from thermal overloads, phase-loss and locked rotor conditions. In addition, an option of over-current trip (selectable) shall be provided to prevent damage due to short-circuits.

External electronic or thermal overload relays may be proposed as an option.

- Adequate heat sinking shall be provided. Further, a thyristor overheat trip shall be provided for added protection.
- Adequately sized terminals shall be provided for linking to cables. Where busbars are used, terminal expansion attachments shall be provided accordingly.

**Technical Support**

The equipment shall be supplied complete with comprehensive documentation comprising the installation and operation instructions. In addition, the following documentation shall be provided on request and where applicable:

- Selection details including starting curves based on manufacturer's recommendations.
- Coordination tables (where used) for Type-2 coordination as per IEC.
- Connection drawings for the scheme used.

- Basic trouble-shooting guide (if not already included in the ops manual)

**General**

The equipment shall be compliant with the following wrt operation:

- Rated installation voltage of 690Vac.
- Starter shall be typically for minimum 6 starts per hour (subject to application type and kW rating)
- For units used in continuous running with fewer starts, a bypass contactor recommended by the soft starter manufacturer shall be used to minimize heat loss.
- Actuation of bypass contractor shall be achieved by using relay output on completion of ramp up.
- Operating temperature shall be 0oC to 50oC with adequate derating where required (application dependent). Also, the equipment shall be suitable for normal operation without derating, within an altitude range of 0-1000 meters.

## 2.15 ELECTROMECHANIC MOTOR STARTERS

**Where these starters do not fall under the electrical sub-contractor's scope of work, the specifications may be used for all co-ordination works.**

**A.** Provide motor starters of electromagnetic, air break type suitable for 3 phase, 50 Hz., 415V, AC System and in accordance with IEC 947-4

**B.** Starters shall be of the plug-in type mounted on withdrawable trays including power and control plug pins and earthing contact with facilities for padlocking.

**C.** Starters controlling motor less than 11 KW may be of the direct on line type. For motors of 11 KW and higher ratings employ automatic star delta starters. Starters shall be provided with three phase overload relays having thermal characteristics suitable for the associated motor and its starting characteristics and suitably compensated for ambient air temperature variation. In addition, provide single phasing protection. Means should also be inherent in the starter for automatically disconnecting the motor from the electricity supply in the event of interrupted supply or under voltage. Provide earth leakage protection for all motors.

**D.** Starters shall have in addition to the auxiliary contacts required for interlocks, alarms, BAS, and controls two additional sets of normally open and normally closed contacts.

**E.** Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2 co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range.
The specifications mentioned in the MCCB's section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device.
The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.

**F.** For each starter, provide the following :

1. 1 set of 'ON' and 'OFF' push buttons for starting and stopping of motor.
2. Red and Green indicating lamps to show status of motor.
3. Suitably scaled ammeter with selector switch for each motor above 7.5 KW.
4. All auxiliary contacts for BAS.
5. Instruments for KW indication by BAS.

**G.** For each motor circuit, its associated circuit breaker and its starter shall be housed in one cell or unit and interlocked so that cell door cannot be opened and started unit cannot be withdrawn unless the breaker is in the 'OFF' position.

## 2.16 AUTOMATIC VOLTAGE STABILISER

Wherever specified/indicated, the stabilizer shall be constructed on booster transformer principle. The rating of the stabilizer shall be as indicated on drawings or as specified in the B.O.Q

**Technical Requirements**

| | |
|---|---|
| Ambient Temp. | up to 50 °C |
| Cooling type | Natural air cooled |
| Input | 415V AC ±15% at 50Hz |
| Output | 415V AC±2% at 50 Hz |

The stabilizer shall be equipped with filters for transients, compensator for unbalanced load in 3 phases, protection against faults and malfunctions. The stabilizer shall be fixed with 3 Ammeters, voltmeters

## PART 3 – EXECUTION

### 3.01 CIRCUITS AND CONNECTIONS

**A.** Provide all outgoing circuits with separate compartment and/or screen so that equipment for any one circuit can be maintained without risk of contact with line connections on any other circuit.

**B.** Connect feeders, for circuits rated upto 63A, to terminal blocks located in separated compartments at top or bottom, conveniently arranged to facilitate termination of cables and suitably identified.

**C.** For feeders, rated more than 63A, suitably extend copper links rigidly supported and covered with coloured PVC sleeves.

**D.** Provide all feeders with cable lugs and brass cable glands.

**E.** Provide removable gland plates suitable for the glands required for the specified cables. Where cables are single core, the gland plates shall be of a non-ferrous metal.

**F.** Provide all small wiring of stranded copper, not less than 2.5mm$^2$ with PVC insulation to B.S. 6231. Small wiring shall be neatly bunched and

cleated in harness form, or shall be enclosed in purpose made plastic trunking or troughing. Wiring cleated to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels, holes shall be grommeted with suitable grommets.

**G.** Connect small wiring associated with external circuits to terminal strips conveniently arranged.

**H.** Provide each connection with separate incoming and outgoing terminals with no more than two wires to be connected to any terminal.

**J.** Wire all spare contacts to terminal strips suitably positioned.

**K**. Identify all wiring using plastic ferrules at both ends

## 3.02 FLEXIBLE CONDUITS

A. The final conduit/connections to motors or apparatus shall be in flexible conduits

*** END OF SECTION ***

# LIGHTING SYSTEM

## PART 1 GENERAL

### 1.1 GENERAL REQUIREMENTS

A. The work of this Division shall be governed by the following documents:
1. Conditions of Contract.
2. Instructions to Tenderers.
3. Form of Agreement.
4. General and Special Conditions of Contract.
5. Form of Tender.
6. Appendices.
7. Applicable Divisions.

B. Comply with requirements of Section 16010 electrical General Provisions.

C. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

### 1.2 SCOPE OF WORK

A. Supply all labour, tools, services and equipment and provide all the materials required to complete this section of the work.

B. The lighting installation for this project shall consist of the following systems but shall not be limited to.
1. General lighting.
2. Emergency and exit lighting system as shown on drawings and luminaire schedule.
3. Exterior and site lighting.

C. Generally the lighting installation shall be carried out by installing conduits within the building structure and walls forming a flush installation in mechanical rooms, electrical switch rooms and other service areas the installation shall be on the surface.

D. Generally some of the lighting installation may be switched utilizing

programmable low voltage switching.

E. Emergency lighting and exit signs shall be connected as shown on drawings.

F. External lighting shall be contactor controlled incorporating photo electric master control.

## 1.3 QUALITY ASSURANCE

A. Acceptable Manufacturers.

1. Subject to compliance with the requirements of the Contract documents, acceptable manufacturers are to be firm regularly engaged in the manufacturer of lighting fixtures of similar quality whose products have been in satisfactory use under similar service conditions for not less than ten years.

## 1.4 SUBMITTALS

A. Reference Applicable Divisions – Submittals

B. Reference Applicable Divisions - shop drawings, products and data and samples.

C. Submit shop drawing of:
Each type of lighting fixture detailing.

i. Catalogue illustrations of luminaire proposed for each specified application.
ii. Design and installation requirements.
iii. Photometric curves and isolux diagrams for each luminaire with indication of minimum light output ratio.
iv. Date indicating each luminaire type's maximum and minimum ambient operating temperatures, and special features, where applicable to withstand onerous conditions, ie. High ambient temperature, intense direct sunlight blowing sand and grit, salt laden air etc.

Computer print out of exterior flood lighting of the building.

D. Samples and shop testing.

Fxture (Recessed type)

i. For the lighting fixture (recessed in F.C) the contractor shall obtain from he ceiling manufacturer a 3m x 3m sample of the ceiling assembly for the Jebsum F.C. The fixture manufacturer shall finalize the details and dimensions the fixture recessed to be co-ordinated with and accommodate the ceiling assembly.

ii. Inform the engineer fourteen (14) days in advance of the assembly being completed and obtain the consultant approval for the assembly.

E. Spares

Provide spare luminaires, control gear, lamps and louvres as listed hereinafter.
Luminaries : recessed type: 50 No.

Lamps

i. Provide 20% spare & tubes of each lamp & tube type and rating with a minimum of 10 lamps or tubes of each type and rating.

Control Gear

i. Provide 20% control gear of each control gear type and rating with a
minimum of 10 control gear per type and rating.

Louvres & Lenses

i. Provide 5% spare lenses & louvres of each type.

Emergency conversion modules.

i. Provide 10% of each type with a minimum of 5 modules per type and
rating.

## 1.5 DESIGN CRITERIA

Generally, all luminaires have been selected to achieve the underlisted illumination

levels for the reflectance's of surfaces applicable, and a maintenance factor of 80% -

90%:

| Location/Function | Min. Service Illuminance (LUX) |
|---|---|
| Archives | 500 |
| Conference Room | 500 |
| Corridors | 100 |
| Entrance Hall | 400 |
| Mechanical Plantroom | 300 |
| Meeting room | 400 |
| Offices | 500 |
| Public Areas | 200 |
| Pump Room | 200 |
| Stairs | 200 |
| Store | 300 |
| L.V. Room | 300 |
| Pantry | 150 |
| Toilets and lockers | 200 |
| Waiting Area | 300 |
| Lounge | 250 |

**Note**: Max. Service illuminance shall not exceed 20% of the above levels.

PART 2-PRODUCTS

## 2.1 LUMINARIES - GENERAL

A. Standards

1. IEC Standard 61 - Lamp Caps and Holders.
2. IEC Standard 64 - Tungsten Filament Lamps.
3. IEC Standard 81 - Tubular Fluorescent Lamps.
4. IEC Standard 82 - Ballasts for Tubular Fluorescent lamps.
5. IEC Standard 155 - Starters for Fluorescent Lamps.
6. IEC Standard 188 - High Pressure Mercury Vapor Lamps.
7. IEC Standard 259 - Miscellaneous Lamps & Ballasts.
8. IEC Standard 598 - :luminaires, incorporating:

Part 1: 598-1, General requirements and tests - 1979 including all subsequent amendments.

Part 2: 598-2, Particular requirements including 598-2-1; fixed general purpose luminaires - 1979, 598-2-2; recessed luminaires - 1979, 598-2-5; Floodlighting – 1979, 598-2-19; Air handling luminaires - 1981, chain suspensions - 1982.

B. Equipment

1. Luminaires shall be completely self continued, unless otherwise specified, and include all control gear, lamp holders, reflectors and diffusers, as required.
2. Luminaires shall be recessed, surface-mounted or suspended as indicated on the Drawings, by code reference and identified in luminaire Schedule and Data sheets.
3. All diffusers shall be of the light stabilized and non-discoloring type.
4. The design, construction and finish of all luminaires shall be entirely adequate for operation in the ambient conditions and at the supply characteristics stated in section 16010 of this specification. All luminaires shall be designed and installed to permit easy relamping.
5. Where possible a terminal block shall be provided inside each luminaire and the wiring between this terminal block and lamp holders, choke, capacitors, etc., shall be completed in heat resistant ($135^{o}$C) cable of adequate size. Terminal blocks fixed to outside of luminaire housings shall be shrouded type with cable cord grip.
6. Where space is not available for the installation of a terminal block at the

luminaire, a separate terminal block shall be provided in an adjacent junction box connected back to the luminaire in heat resistant (135$^{o}$C) cable of adequate size.

7. All luminaires shall be suitable for connection to rigid conduit, and/or flexible circular sheathed cable.

8. all weather-proof luminaires shall be fully suitable for outdoor use and shall not deteriorate after extended use in the ambient site conditions state.
9. All mounted luminaires shall be connected to the control box in heat resistant (135$^{o}$C) cable.

C. Fluorescent Luminaires.

1. Fluorescent luminaires shall be constructed of mild steel sheet finished with an approved colour using an electrophoretic dip or electrostatic spray system. The luminaires shall be of a construction which ensures rigidity and a minimum of twisting, distortion, and light leakage.
2. All fluorescent luminaires specified for 26mm diameter fluorescent tubes shall be complete with electronic start type control gear with automatic resetting and RFI suppresser. All control gear shall be suitable for operation in ambient temperatures up to 50 Deg. C.
3. Control gear shall comply with BSI standards and be of the 'silent' type.
4. All fluorescent fitting Ballasts units shall be fitted with power factor correction capacitors which improve the power factor to not less than 0.9 lagging except where are electronic ballasts then no need for capacitor.
   Wood chokes for T26 and compact fluorescent lamps.

   i) Copper wire wound Ballasts with very short magnetic paths, vacuum impregnated and topicalised, suitable for operation from 230V/50Hz single

   phase AC supply, Class H insulation, maximum winding temperature of 130$^{o}$C and push in terminals. The ballasts shall be of low loss type, with losses not exceeding the values given below.

   - 18W - 6.5W

**- 36W - 6W**

   - 58W - 9W
   - 24W - 6W
   - 36W - 6W
   - 18W - 4W

   ii) Electronic ballasts for T26 and compact fluorescent lamps.
   Ballasts comprising passive electronic components, to run the lamps at a

frequency of 35-40kHz.

iii) Transformer for LV Halogen lamps.
Transformer operating at high frequency
(approximately 35 kHz) with constant secondary voltage, built in overload
and short circuit protection and automatic re-set, harmonic filter, RFI suppression clip on terminal covers with strain relief.

5. All luminaires shall be designed for operation from a 230 volt 50 Hz single phase supply, unless specifically indicated otherwise on the Drawings.
6. Luminaires body, housing and reflector shall be of the shape and size as indicated in the Luminaire Data Sheets.
7. Control gear shall be quiet in operation and no part of any luminaire shall rattle when subjected to normal internal building environmental vibrations.
8. Luminaires shall be manufactured to enable simple and efficient cleaning. The external surfaces of all luminaires shall be smooth and devoid of apertures or crevices. Seams and joints shall be continuously welded and ground smooth.
9. luminaires body, reflectors, wiring channels and castings shall be formed so as to prevent buckling or distortion.
10. When aluminium is placed in contact with dissimilar metal, the contact surface shall be separated with a gasket or coating to prevent corrosion.
11. all luminaire latches or other securing means shall be of the captive type.
12. Fluorescent luminaires shall be suppressed for radio interference to recognized international standards.

D. Discharge Luminaires

1. All discharge luminaires used in internal applications shall comply with the requirements of British Standards code of Practice BS 4533: 2.2 and shall conform to the IP rating indicated on the luminaire schedule and the Luminaire Data sheets.

2. All discharge luminaires used in external applications shall comply with the requirements of Standards and shall be minimum of IP 54 unless indicated otherwise in the following Luminaires Data Sheets.
3. All luminaires shall be designed for operation from a 230 volt 50 Hz single phase supply, unless specifically indicated otherwise on the Drawings.
4. all luminaires shall incorporate, within the base, a cable connector suitable for accepting 6.0 sq.mm conductors. Luminaire factory wiring shall be rated at 155$^{o}$C.
5. Luminaires body, housing and reflector shall be of the shape and size as indicated in g Luminaire Data Sheets.
6. Control gear shall be quiet in operation and no part of any luminaire shall rattle when subjected to normal internal building environmental vibrations. Ballasts shall be high power factor type not less 90%.
7. Luminaires shall be manufactured to enable simple and efficient cleaning. The external surfaces of all luminaires shall be smooth and devoid of apertures of crevices. Seams and joints shall be continuously welded and ground smooth.
8. Luminaires, body, reflectors, wiring channels & castings shall be formed so as to prevent buckling or distortion.
9. When aluminium is placed in contact with dissimilar metal, the contact surface shall be separated with a gasket of coating to prevent corrosion.
10. All luminaries latches or other securing means shall be of captive type and made of stainless steel for luminaires mounted externally.
11. All luminaires shall be suitable for starting, and operating continuously, within the following ambient temperature range.
12. Minimum Temperature -2 Deg. C.
    Maximum Internal Temperature 46 Deg. C
    Maximum External Temperature 50 Deg. C
13. All discharge luminaires shall incorporate power factor correction to not less than 0.9 lagging.

E. Emergency Conversion Module

Where shown on drawings, emergency lights shall be equipped with emergency conversion modules. The module shall be a 3 hours, maintained type, sealed with rechargeable Nickel - Cadmium battery, rated for use at 50$^{o}$C ambient.
Charger/inverter unit shall have red LED charger monitor.

Mains Voltage - 230V +6% or -10%

| | |
|---|---|
| Mains Frequency | - 50Hz |
| Power consumption | - 7.5W/9VA |
| Insulation Class | - 1 |
| Battery | - 9.66V/4Ah |
| Re-charge Period | - 24 hr. |
| Approvals | - BSI/IEC 598-2-22 |
| Lamps | -Fluorescent lamps-T26-18W,36W & 58W,8w<br><br>-Compact Fluorescent TCL 24W & 36W<br>Lamp - TCD 18W |
| Ballast Lumen Factor | 18W – 0.46<br>36W – 0.20<br>58W – 0.15<br>24W – 0.26<br>36W – 0.20<br>18W – 0.44 |

F. Emergency conversion modules are to be incorporated inside the luminaires except if luminaire construction does not allow, it may be remotely mounted in a steel box complete with grommets to cable entry and connectors.

G. Remotely Mounted Control Gear

Provide where shown on drawings, remotely mounted control gear for floodlights illuminating the building facades. Control gear shall be mounted in purpose made enclosures in the low voltage switchgear room. The enclosure shall be

fabricated in sheet steel, equipped with lighting control gear and fitted with incoming

cable gland plate, contactor control and incoming switchgear with tripple pole MCB

circuit protection to each lighting control gear tray.

The tray shall be pre-wired complete with control gear.

H. Low Voltage Halogen Lamps.

1. All lamps shall be suitable for operation from 12V AC single phase, 50Hz.
2. They shall have the low-voltage halogen burner optically positioned in an aluminium reflector equipped with an integral protective front glass.

3. Lamps shall be of BI-PIN cap B15d.

Lamps shall be in accordance with the following schedule.

| Wattage | Base | Intensity | Life (Hrs.) |
|---|---|---|---|
| **50W** | **B15d** | **2000cd** | **2000** |

I. Normal Voltage Halogen Lamps
1. They shall be of the single ended, double enveloped type.
2. They shall be suitable for operation from 230V/50Hz, Single Phase AC.
3. They shall be suitable for universal burning positions.
4. They shall be in accordance with the following schedule.

| Wattage | Base | Lumen | Life (Hrs.) |
|---|---|---|---|
| 100W | E27 | 1525 | 2000 |

J. Fluorescent Lamps
1. Fluorescent lamps shall be of 26mm dia., suitable for operation from 200-250V AC, single phase.
2. They shall be of switch start type with daylight appearance.
3. They shall be in accordance with following schedule.

| *Wattage* | *Base* | *Lumen* | *Life (Hrs.)* |
|---|---|---|---|
| 18W | G13 | 1050 | 7500 |
| 30W | G13 | 2000 | 7500 |
| 36W | G13 | 2500 | 7500 |
| **58W** | **G13** | **4000** | **7500** |

K. Compact Fluorescent Lamps

1. They shall be single ended, with two or more narrow fluorescent tubes, as shown on luminaire schedule

2. Colour appearance shall be day light.

3. They shall be in accordance with the following schedule.

| Wattage | Base | Lumen | Life (Hrs.) Output |
|---|---|---|---|
| 18W | G24d-2 | 1200 | 5000 |
| **26W** | **G24d-3** | **1800** | **5000** |
| 24W | 2GII | 1800 | 5000 |
| 36W | 2GII | 2900 | 5000 |

L. Discharge Lamps

1. All discharge lamps shall comply with IEC Standard 188
2. Lamps shall be in accordance with the following schedule:

| Type Lamp | Wattage | Base | Initial | Life Lumens | |
|---|---|---|---|---|---|
| Metal Halide | MBI-T | 150 | - | 12000 | 6000 |
| Metal Halide | PAR 64 | 1000 | - | 76000 | 3500 |

M. Luminaire Louvres & Lenses

1. Louvres shall be manufactured from Anodized semi-specular aluminum reflector sheet. Sheilding assembly to be supported by concealed hinges and snap action latches opening from either side with fingertip pressure, to give clean uncluttered appearance to luminous cavity (no visible hardware, rivets etc.).
2. Lenses shall be acrylic with a minimum thickness of 3.175mm.

N. Luminaire Data Sheets

1. The luminaire data sheets define the quality and design/performance of all luminaires which shall be supplied and installed, with locations and quantities as indicated on the Drawings.

## 2.2 EXIT SIGNS

A. Shall be bilingual, details as shown in the following documents and to the approval of Civil Defense authorities:

- Signage and Graphics
- Luminaire Schedule
- Electrical Drawings
- Data Sheets included herein.

PART 3 EXECUTION

## 3.1 INSTALLATION GENERAL

A. Refer to Section 16010.

## 3.2 INSTALLATION OF LIGHTING FIXTURES AND LAMPS.

A. Provide all lighting fixtures and lamps shown on the drawings luminaires schedule and data sheets attached herein.

B. Include for assembly, and mounting of all fixtures, complete with all wiring, connections, fittings, hangers, aligners, box covers and accessories which may be required for any fixture to provide a complete, safe, fully operational assembly.

C. Generally, install fixtures in accordance with applicable reflected ceiling plans and/or as directed by the Architect. In equipment rooms, shafts and similar secondary areas, install fixtures after the mechanical and other major work is roughed-in and adjust fixture locations as required.

D. Thoroughly review all ceiling types, construction details and mounting arrangements before placing fixture orders and ensure that all mounting assemblies, frames, rings and similar features are included for and match the requires installation.

E. All fixtures and fixture assemblies shall be properly secured and supported. Support fixtures independent of the ceiling construction complete with all fasteners, framing and hangers. Do not secure fixtures to mechanical ductwork or other vibration producing apparatus unless specifically detailed on the drawings.

F. Where fixtures are suspended from the structure they shall utilize self aligning box covers with an additional ground wire from the outlet through the hanger for continuity of ground.

G. Carefully co-ordinate the fixture installation with the work of other trades ensuring that the necessary depths and mounting spaces are provided. Do not alter fixture locations unless approved by the Architect.

H. All lamps shall be new and intact when the project is complete, and ready for acceptance.

I. Provide safety chains on all surface mounted or suspended fixtures.

J. The final connection to all luminaries integrated into suspended ceilings shall be by means of flexible heat resisting cable terminated at a plug and sockets ceiling rose mounted in the ceiling void directly adjacent to the luminaire. All such ceiling roses shall be appropriately rated to suit the rating of the associated sub-circuit protective device. The plug and socket ceiling rose shall be located directly above or adjacent (within a horizontal distance of 1.5m from the centre of the fixture) at the side of luminaire such that it is readily accessible for disconnection and maintenance.

K. Earthing

1. All luminaries of metallic construction shall be suitably earthed, the earth wiring being connected by a terminal provided within each fitting specifically for this purpose.

2. Where luminaires are suspended, a cable protective conductor shall be connected between the fitting and the final sub-circuit wiring installation.

L. Luminaires Commissioning and Testing

1. At the discretion of the Engineer, make-up site test and demonstrate the operation of special application of fixtures such as building floodlights, landscape fixtures and other decorative fixtures, and adjust their locations within a reasonable distance to obtain the effects desired to the approval of the Architect. Assist in the aligning and positioning of all adjustable fixtures, and ensure that fixtures with adjustable lamp holders are properly positioned to correspond with the lamps specified.

## 3.3 EXIT SIGNS

A. Provide all Exit Signs as scheduled and shown on the drawings, signage and graphics document and luminaire schedule.

B. Directional arrows on Exit lights shall be as shown on drawings and in accordance with local Civil Defense Department requirements.

***** END OF SECTION *****

SECTION 16620

EMERGENCY DIESEL GENERATOR

*PART 1 - GENERAL*

## 1.01 GENERAL REFERENCE

A. The work of this Section is integral with the whole of the Contract Documents and is not intended to be interpreted outside that context.

B. Coordinate the work with all other services affecting the work of this Section.

C. Diesel Generator submittal without compliance statement from the manufacturer shall not be acceptable.

## 1.02 DESCRIPTION OF WORK

A. The Contractor shall comply, install, commission, test and hand over in good operable manner including one year guarantee and maintenance. 415 V automatic starts on mains failure, standby diesel generator set as indicated on the drawings. The set shall be complete with diesel engine, generator, control panel, batteries, starting motor, built-in air cooled radiator, main fuel storage tank, daily fuel storage tank, fuel transfer pumps and all other accessories as specified and mentioned in the B.O.Q.

## 1.03 RELATED WORKS SPECIFIED ELSEWHERE

A. General Provisions for Electrical Installation
B. Basic Materials and Methods
C. Cable Trays
D. Conduits
E. Trunking
F. Wires and Cables
G. Earthing System

**APPLICABLE STANDARDS REFERRED TO IN THIS SECTION**

A. BS 5514: Engines

B. BS 4999: Alternators

## 1.04 QUALITY ASSURANCE

### A. Manufacturer's Qualification

1. The generator set shall be the product of a single manufacturer regularly engaged as a manufacturer of such equipment. The engine, alternator, control panel shall be designed, manufactured, assembled and tested by single manufacturer. The manufacturer shall be responsible for a single source warranty for the entire diesel generator set, including the controls.

### B. Installer's Qualification

1. All the Diesel Generator installation work shall be carried out by a Diesel Generator Sub-Contractor. Diesel Generator Sub Contractor shall be one who is normally and agent representing one or more of the approved makes of D/G sets. Diesel Generator installation shall be supervised, checked and tested by a qualified representative of the manufacturer and hand over the works in perfect running order to the satisfaction of the Engineer.

### C. Source Quality Control

1. Test the combined engine generator set at the factory and submit the certified test copies of all tests to the Engineer for his approval.

### D. Design Criteria

1. All materials and equipment shall comply with relevant IEC and BS specifications in regards to quality of materials, performance and proving tests.
2. The emergency power supply and its components shall be such as properly maintained and services without the necessity of carrying expensive spare parts stocks, or being subjected to interrupted service due to the lack of spare parts.
3. Emergency generator set shall be designed to allow easy replacement of major items subject to wear.

## 1.06 SUBMITTALS

### A. Shop Drawings

1. Submit 3 copies of shop drawings for approval.
2. Shop drawings shall be complete, as to be as-built drawings, not general outline drawings used for sales and guide layouts.
3. Submit a complete wiring diagram for the generator set, drawn on a single standard size sheet, showing the following:
    a) All components of:
        i) Engine starting control
        ii) Engine alarm
        iii) Generator control
        iv) Battery
        v) Battery charger
        vi) Earthing
        vii) Transfer switch control relays.
    b) Interior wiring, terminals and interconnecting wiring.
    c) Certified dimensions and weights.
    d) Clear indication of all connections to remove equipment including details of working interface with B.A.S. system for alarm monitoring.
4. Submit a composite wiring diagram of the entire emergency transfer system showing all wiring between the engine starting panel, engine generator set and the automatic transfer switches.
5. Wiring diagrams shall clearly show:
    a) Main current conductors, in heavy lines.
    b) Control conductors, with colour and/or number coding.
    c) Location of relays and apparatus.
    d) Description of function, type and catalogue, of all components.
6. Alternator Control Panel
7. Submit a schematic line diagram showing:
    a) Interlocks
    b) Protection
    b) Instruments

**Service Facilities**

1. Indicate the nearest location from which service facilities and spare parts may be obtained after the guarantee period.

*Test Reports*

1. Submit certified copies of data obtained during factory test of the engine generator test.

*Operation and Maintenance Data*

1. Submit certified copies of data obtained during factory tests of the engine generator test.
    a) Manuals for generator set.
    b) Detailed instruction books.
    c) Operator's manuals.
    d) Maintenance schedules.
    e) Part catalogues.

2. Submit 3 copies of the following:
    a) Complete instruction covering the operation of the engine generator set and associated equipment.
    b) A manual covering engine operation and maintenance.

3. Fix one copy of the composite wiring diagram of the emergency transfer system inside the transfer switch compartment door and another in the generator control panel.

4. Fix as-built print each generator set, frames behind non-glare plexiglass, on a wall near the generator control room.

*Spare Parts*

1. Provide the spare parts for 2 years operation and maintenance, properly preserved and packed in a suitable steel box with a lock and two keys marked "Spare Parts: Engine Generator Unit".

*Product Delivery, Storage and Handling*

1. All generator equipment-using eyes, yokes and skids provided by the manufacturer.

2. Do not store equipment assemblies exposed to weather.

3. Physically protected all generator equipment against damage from work of other trades.

4. Cover all generator equipment with suitable material to avoid damage to finish.

## PART 2 - PRODUCTS

### 2.01 EMERGENCY GENERATOR SET

A. The set shall be of rugged reliable design and built for long trouble free service under the worst specified climatic conditions and made by an approved reputable manufacturer.

B. The rated output shall be (as indicated on drawings) at 0.8 PF 240/415 Volts, 3 phase and 50 Hz. The rated output shall mean the net full continuous derated output in Palestine at ambient temperature up to 45 Degree C, at relative humidity 50%. The set shall also be capable of 110% load for one hour under these conditions at the rated speed without undue heating of the engine or alternator and without mechanical or electrical troubles. A manufacturer's deration calculation shall be enclosed along with the tender documentation.

C. Diesel Engine

**1.** The diesel engine shall be of the stationary heavy duty and **EU stage II emissions compliant**, turbo charged compression/ignition, multi cylinder 4 stroke operation. The steel base frame shall be provided with spring type vibration isolators. The engine shall be able to deliver full load in the shortest possible time after start. The engine speed shall not exceed 1500 r. p. m.

The engine construction shall be in such a way as to allow for dismantling of any engine component for inspection or repair without undue complication i.e. without dismantling of other non--defective parts. The crank-case shall be provided with inspection windows.

**2. Starting System**

The diesel engine shall be equipped with starting system detailed hereunder and as per Engineer's approval.

**a) Battery Starting System**

i) The engine shall be started by a 24V, D.C. starting motor automatically engaging with engine flywheel and positively dis-engaging on engine starting.

The engine starting control equipment shall be arranged to disconnect the battery charger to prevent it from being over-loaded during starting. The starter motor shall be of adequate power of its duty

ii) Batteries for starting shall be of the nickel cadmium type, 24V, and heavy-duty diesel starting type and of sufficient capacity to provide continuous cranking of 1.5-minute duration without recharging. Batteries should have sufficient capacity to provide three successive starts.

iii) The batteries shall be filled with electrolyte an installed on proper racks with cables and clamp. A hydrometer shall be supplied with the batteries.

iv) The battery charger shall be static type 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.

v) 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 stare 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.

vi) An ammeter and voltmeter in the control panel shall indicate the state of the battery and its charging rate.

## 3. Cooling System

a) Radiator: Built-in type sufficient capacity to dissipate the total joules per hour rejected by the engine cooling system at 110% full load.

b) Blower fan: To have sufficient pressure to circulate required quantity of air for engine cooling. The fan shall be provided with a suitable guard. D/G room inside temperature should not exceed 56 Degree C.

c) Jacket water heaters: To be provided on engine to facilitate quick under low ambient conditions.

d) The cooling system shall be capable of keeping the

temperature of cooling water at safe limits at all conditions of load required in the Specifications. Maximum temperature of cooling water after 10 hours of Continues running at full load at worst Palestinian climatic conditions shall not exceed the maximum temperature limits of the diesel engine.

e) The cooling system shall include an engine shaft driven circulating water pump. The water jacket of the engine cylinder shall be so constructed that the water in the jacket can be drained completely.

f) The radiator-finned tubes shall have a common inlet and common outlet headers.

g) A drain valve and a filling valve shall be provided to the radiator for flushing and quick filling.

h) The radiator shall be equipped with suitable rated immersion heater with integral thermostatic controls in order to prevent freezing when standing idle during cold climatic. Cooling water piping, complete with all necessary supports, control valves, flanges and fittings, thermometers, pressure gauges, relays etc.., shall be supplied and installed to form a complete engine water cooling line. Piping shall be as of B.S. 1387.

i) The pump discharge valve shall preferably be a globe valve; the other valves shall be Sluice gate valve.

## 4. Fuel System

a) The set shall be suitable for running on diesel oil as described below:

| | |
|---|---|
| Specific gravity at 60F distillation (P. P.123/40) | : 0.834 |
| IBM | :219 C |
| 10% | : 250 C |
| SO% | : 276 C |
| 90% | : 314 C |
| F.E.P. | : 342 C |
| Flash Point PME | : 189 C |
| Sulphur | : 1.1 % |
| Calorific value | B.T.U./lbs gross |

| | |
|---|---|
| Carbon residue | : 19750 |
| 0.01/wt diesel index | : 62 |
| Viscosity redwood seconds at 100F | : 34 |

b) **Daily Fuel Tank**

An integeral day tank located under the Generator set shall maintain fuel supply to the engine. The fuel tank shall be of sufficient capacity for continuous run if 8 hours at full load, and shall be fitted with strainers (see filter), control cocks, drain cock, piping to the engine and a level indicator with alarm contacts, vents and all other necessary fuel lines and fittings.

c) **Storage Tank**

The Contractor shall supply and install stand mounted diesel oil storage tank with a capacity of 2000 liters as per.
The storage tank shall be complete with pipes, fittings, feed lines, vents etc. The tank shall be of the approved type located inside the diesel generator room. The tank construction and method of installation shall comply with BS 2594/1955 or approved equal.

d) **Tank Gauges**

Provide as required a gauge to indicate level of fuel in the tank. Mounted on gauges shall also be a high/low level alarm switch. The switches and gauges shall be designed for a 240 Volt single phase, 50 Hz systems. Locate indicating gauges as deemed necessary.

e) **Fuel Oil Piping & Fuel Filling System:**

i) The generator shall be equipment with a factory assembled automatic fuel filling system consists of required control, low/high level switches and gear fuel pump.

ii) Provide all diesel fuel oil piping from storage tank to day tank fill lines, water tight fill boxes, vents, vent caps, tank foot valves, and accessories.

Provide swing check valves and gate valves at pump inlets. Provide approved anti-siphon valve at high points of suction lines. Provide whatever

additional valves that may be required by local regulations.

iii) All piping shall be provided with ground joint unions at piece of apparatus to facilitate connecting and disconnecting.

iv) All piping, unless otherwise specified, shall be schedule 40 standard weight black wrought iron pipe.

v) Steel vent pipelines shall run from the fuel oil storage tanks, carried to the proper height within building construction and terminating with vent fittings. Fitting as required.

**5. Lubricating System**

a) The lubricating oil system shall be forced fed type. The details of the system shall be included in the offer. The shaft bearing lubricating shall be directly fed from the lubricating oil pump and not through the main bearings.

b) The lubricating oil shall be of a type readily available internationally.

c) The lubrication system shall be positive displacement type. By-pass arrangement should be provided in case of filter clogging.

d) A heat-exchanger shall be provided for cooling the lubricating oil and this shall be of long-life type i.e. the system shall not require constant cleaning or other maintenance work. A valve for taking oil sample shall be provided. The coolant for the above shall be jacket water of the engine. That is, the cooling system of the engine and the lube-oil heat-exchanger cooling system shall work in parallel or in series. If the lube-oil pressure reaches low value, the engine shall be shut down automatically and also immediately should give audible alarm together with visual at important points at the engine-monitor panel.

e) Suitable manual-pumping arrangement for easy draining of the whole quantity of lube-oil into a drum shall be provided.

**6. Exhaust System**

a) Exhaust pipes shall be of Schedule 40 black for easy steel and of adequate size to ensure that back pressure does not exceed the value specified by the manufacturer.

b) The exhaust pipe shall be connected through airtight flexible coupling to the engine.

c) Exhaust pipes shall be adequately lagged with 75 mm thick (minimum) rock wool covered with aluminum sheaths so that to take care of exhaust gas temperature in pipes exceeding 500 Deg. C. When exhaust pipes pass through walls or roof a suitable weatherproof sleeve or thimble shall be provided to isolate exhaust pipe from the building. A silencer of heavy-duty residential type shall be provided in the exhaust system and it shall also be lagged. Civil contractor will carry out the operation of casting the sleeves in the concrete, if required.

d) Exhaust pipes and silencers shall be supported from the ceiling by special vibration isolating hangers and the pipe shall be slanted away from the engine and a condensate trap fitted at the lowest points. Approved rain caps shall be installed at the discharge end of the exhaust pipes on the roof.

e) Suitable flexible expansion joints shall be provided along the pipe run to take care expansion requirements.

**7. Filters**

Cleanable/replaceable elements should be provided.

**a. Fuel Oil System**

The system shall have the following filters fitted before the fuel injection pumps:

A fuel filter system of ample capacity to prevent all particles of 3 microns size or smaller shall be provided

**b. Lubricating Oil System**

i) This system should have full flow filters of sufficient capacity.

ii) Tenderers shall give full particulars of the filters used. It shall be mentioned in if filter elements are cleanable for replaceable, in which case, the working hours after which

the element and the lubricating oil is to be replaced should be stated.

**c. Intake and Exhaust System**

Air is inducted to the engine manifold through.

i) Pre-cleaner
ii) Large capacity air cleaner.

Both filters are required due to severity of dust suspensions in the air.

The engine exhaust line shall be fitted with flexible fitting efficient silencer to give efficient silencing with minimum back pressure and terminated outside the engine room.

**8. Ventilation**

The following ventilation works are required for the diesel engine generator room.

a) Metal louvers with metal cleanable filters shall be provided for outside air intake into the engine room. Filters shall be permanent heavy-duty metal cleanable type minimum 2" thickness. Filters to be sized to perform their duty with a face velocity not more than 350 fpm when engine is running. Filters to be installed n an appropriate arrangement on the room walls. Total filter area shall consider air for engine intakes and radiators cooling. Filters with handles and latches shall be provided.

**9. Governing System**

a) The engine shall run steadily at any load within its rating at its rated speed, and the changes in speed due to change in load shall comply with BSS 5514/77 for Class A1 or with ISO 3067.
b) The governor should be of the electronic type to comply with BS 5514/77 Class A1.

**10. Coupling and Common Bed**

a) The engine and the alternator shall be suitably coupled directly without interposing gear arrangement.
b) The common bed shall be provided with suitable damping devices for fixing to the floor.
c) The engine vibration shall be the minimum possible and shall

comply with the relevant BS. The vibratory force induced as the engine passed through resonance revolutions during starting and stopping period shall not cause any damage to the whole system.

**11. Engine Monitor Panel**

a) Each engine shall be provided with a monitor panel adequately isolated from vibration, which shall contain facility to monitor the following:
   i) Engine speed.
   ii) Temperature.
   iii) Engine operation hour counter.
   iv) Other required items.

b) The engine shall be able to operate manually from the monitor panel. Manual speed control facility shall be provided.

D. **Alternator and Exciter**

1. The alternator shall be able to withstand the stresses caused by the sudden application of the loads.

| | |
|---|---|
| a) Type | Self-excited, self ventilated, air-cooled, splash-proof, synchronous alternator. |
| b) Output | As indicated on the drawings, at Jordan rating. |
| c) Voltage | 415V |
| d) Frequency | 50 Hz. |
| e) No. of poles | 4 |
| f) No. of phases | 3, (neutral to be brought out). |
| g) Power factor | 80% lagging. |
| h) Commercial efficiency | not less than 90% (including excitation and field losses). |
| i) Voltage regulation | Automatic and static. |

2. Class "F" insulation shall be applied to stator, rotor and exciter windings.

3. The alternator shall be suitable for continuous running duty type S1, BS 2613 (latest edition).

4. Distortion of no-load voltage waveform at alternator terminals shall be within 5% from the sinusoidal waveform.

5. Voltage adjustable range of the output voltage by adjusting the exciter shall be not less than 3% of rated voltage at rated load and not less than + -5% of rated under no-load conditions. This adjustment shall be able to be performed from panel mounted handle or knob.

6. The voltage of the alternator shall be automatically controlled by electronic static circuits.

7. The alternator shall not be switched on the load until terminal voltage has reached at least 90% of the nominal value. It is essential that the voltage regulation equipment shall have sufficient fast response time so that the alternator is ready to accept load in the shortest possible time.

8. The voltage regulator shall be designed to maintain the alternator terminal voltage constant within + -1% of the nominal value from no load to full load within normal variations of engine speed with change in load.

9. The exciter shall be brushless, self-excited, rotor mounted type. The rectifying elements shall be silicone.

10. The unit shall be suitably protected so that when there is a sudden variation of load, the sudden increase of field current in the rotor shall be curtailed and thus the speed build up of the engine and the voltage build up of generator shall vary proportionately.

11. Terminals with cable end boxes shall be provided respectively for the alternator and exciter.

12. The cooling air for alternator and exciter shall be drawn through openings at the non-drive end and exhausted sideways at the driving end.

13. The alternator shall be fitted with air-condensation heater to keep the winding in good, dry and safe condition. The air-condensation heater shall be automatically cut-of when the machine is running. Necessary on-off switches shall be provided on the control panel and the operation status of the heater shall be indicated.

14. Temperature Rise

Alternator components shall be sound electrically and mechanically in continuous operation lasting over 24 hours at the rated output.

15. Insulation Resistance

Insulation resistance of the machine at strategic points shall be provided with the offer submitted with the shop drawings.

16. Dielectric Strength

The dielectric strength, the voltage of testing and test procedure at various points of the machine shall be submitted with the shop drawings.

17. Vibration

Vibration at the fixed components of the alternator under excited no-load operation shall be as per relevant BS.

18. Terminal Symbol

a) Terminal symbols for the alternator shall be in accordance with BS 822 requirements.

b) The alternator shall be provided with protection against over speed, over voltage, over current, short circuit, reverse power, earth fault and any other found necessary.

The neutral points of alternators shall be solid by connecting to earth.

19. Panel Wiring

a) All wiring of battery charger, exciter and control panel shall be P.V.C. tropical grade of adequate current carrying capacity to prevent over-heating under worst climatic conditions.

b) All wiring shall conform to the relevant BS and at least 50% derated with minimum size of 2.5 sq. mm. or its equivalent.

20. Terminal Board

a) Terminal boards shall have pairs of terminals for Incoming and Outgoing wires and not more than two wires shall be connected to any one terminal.

b) Insulating barriers shall be provided between adjacent

connectors. Labels for wiring designation marks shall be provided on the fixed portion of the terminal boards as well as wires. No live metal shall be exposed at the back of the terminal boards.

c) Terminal boards having pressure type terminal lusts or equivalent shall be used so that no terminal clamp is necessary. 10% spare terminals shall be provided for each terminal board assembly.

## 2.02 CONTROL BOARD

### A. Cabinet

1. Sheet steel construction, totally enclosed, dust protected and vermin-proof.
2. A hinged, lockable door shall give access to control and instruments.
3. "Live" parts shall be secured to prevent inadvertent contact with them.
4. Controls for diesel engine, alternator, exciter, meters and alarm device shall be positioned to give ample space for removing and installing components.

### B. Instrument in Control Board

1. The generator set shall be provided with a microprocessor-based control system, which is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
2. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
3. The control shall have J1939 port and a Modbus communication port.
4. The control shall be provided with a remote announciator installed in building to show the status and alarms of the generator set, the announciator shall provide the minimum following alarm :

   - Fail to start shutdown
   - Low Oil pressure shutdown
   - High engine Temp.

- Under speed / Over speed
- loss of engine speed detection
- low/ high Battery voltage
- under volts/ Over volts
- under freq / over freq
- over current

5. The control shall be UL508 listed, CSA282-M1989 certified, and meet IEC8528 part 4. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std 801.2, 801.3., and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.
6. The generator set mounted control shall include the following features and functions:
   a) Three position control switch labeled RUN/OFF/AUTO.

      In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

   b) Red "mushroom-head" push-button EMERGENCY STOP switch.

      Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.

   c) Push-button RESET switch.

      The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

   d) Push-button PANEL LAMP switch

      Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall

automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

e) Generator Set AC Output Metering:

The generator set shall be provided with a metering set including the following features and functions:

2.5-inch, 90-degree scale analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.

Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.

f) Generator Set Alarm and Status Message Display:

The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions.

The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:

Low oil pressure (alarm)
Low oil pressure (shutdown)
Oil pressure sender failure (alarm)
Low coolant temperature (alarm)
High coolant temperature (alarm)
High coolant temperature (shutdown)
Engine temperature sender failure (alarm)
Low coolant level (alarm or shutdown--selectable)
Fail to crank (shutdown)
Overcrank (shutdown)
Overspeed (shutdown)
Low dc voltage (alarm)
High dc voltage (alarm)

Weak battery (alarm)
Low fuel-daytank (alarm)
High ac voltage (shutdown)
Low ac voltage (shutdown)
Under frequency (shutdown)
Over current (warning)
Over current (shutdown)
Short circuit (shutdown)
Ground fault (alarm)(optional--when required by code or specified)
Over load (alarm)
Emergency stop (shutdown)
In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

g) Engine Status Monitoring:
The following information shall be available from a digital status panel on the generator set control:

i) Engine oil pressure (psi or kPA)

ii) Engine coolant temperature (degrees F or C) Both left and right bank temperature shall be indicated on V-block engines.

iii) Engine oil temperature (degrees F or C)

iv) Engine speed (rpm)

v) Number of hours of operation (hours)

vi) Number of start attempts

vii) Battery voltage (DC volts)

v) The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

vi) **Control Functions**:

The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.

The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature, which is capable of discriminating between, failed sender or wiring components, and an actual failure conditions.

The control system shall include all interfaces necessary for proper operation with the paralleling equipment provided under this contract. The generator set supplier shall be responsible for complete compliance to all specification requirements for both the generator set and the paralleling equipment.

vii) **Alternator Control Functions**:

The generator set shall include an automatic voltage regulation system, which is matched, and prototype tested with the governing system provided. It shall be immune from mal-operation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alpha-numeric LED

readout to indicate setting level. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.

Controls shall include a load-shed control; to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

An AC over/under voltage monitoring system, which responds only to true RMS voltage conditions, shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

When required by National Electrical Code or indicated on project drawings, the control system shall include a ground fault-monitoring relay. The relay shall be adjustable from 100-1200 amps, and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay which will function correctly in system as installed.

vii) **Control Interfaces for Remote Monitoring**:

All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:

Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.

One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.

A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

A fused 20-amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

## 2.03 SOUND ATTENUATION HOUSING (ORIGINAL)

A. Construction: Provide an overall housing with removable side panels and a hinged, padlockable meter panel door. Unitized construction between the stud and the acoustical enclosure. The maximum sound level measured one meter from the enclosure in free field conditions under full load shall not exceed 72 dBA.

B. Painting: Prime all exposed metal parts with a suitable rust inhibitor applied to the clean bare metal.

C. Acoustical Treatment: Intake and exhaust silencers shall be provided at the ends of the skid.

## 2.04 COMMISSIONING

A. Simulated Power Failure Test

Engine - generator shall be made ready for automatic operation and started by means of the test transfer switch on the automatic transfer switch. Unit shall run for the duration of all time delays and then automatically shut-down. This test shall be made with unit operating, and twice with unit simulated for a starting failure.

B. Testing of the Set

1. Engine

a) The engine shall be tested at sire before and after erection to BS 649 and amendments or equivalent including items, which are said to be subject to mutual agreement. The test shall include inspection, after testing the following parts:

b) Subsequent running test of eight hours shall be carried out of the set.

c) The engine shall be subjected to vigorous performance tests at sire under the worst environmental conditions prevailing here to the satisfaction of the Engineer and the main items shall include:

i) Output characteristics.

ii) Temperature rise.

iii) Checking of valve clearance, fuel pump setting, governor setting, pipeline connections, exhaust piping, and flexible connections.

iv) Checking the base and set are level in all directions, checking alignment of engine and generator and vibration isolators location and proper installation.

i) Checking or proper operation of engine safety devices.

ii) Checking of fuel pipelines, fuel pumps, tank level gauges and level control switches operation.

2. Alternator and Exciter

a) The alternator and exciter shall be tested to BS 5000 P.99 amendments thereof.

b) Tests at sire before erection and after erection prior to handing over shall be carried out to the satisfaction of the Engineer. The main items of tests deemed necessary by the

Engineer shall be carried out at the expense of the Contractor. The performance test shall be for 24 hours under the worst climatic conditions prevailing in Jordan.

c) The Contractor shall be fully responsible to provide all the necessary facilities for the test at his own expense.

## 2.05 SYSTEM RESPONSIBILITY

A. The generating set, switchboard and automatic transfer switches shall be interconnected according to building load requirements and to manufacturer's recommendations, to prevent the emergency generating system from stalling or faltering due to momentary overloads beyond system rating, from distribution faults, motor starting loads.

B. Provide suitable filling point, fuel pump (manual), other accessories complete as required for system completion.

## 2.06 TRAINING FOR OPERATION AND MAINTENANCE PERSONNEL

A. The Contractor shall train a number of persons who will be selected by the Engineer for the operation and maintenance of all the works within the contract before these works are handed over to the Engineer.

B. The training has to be carried out by qualified staff of the Contractor for each specified service and shall be maintained for a one-month period following on the Certificate of Completion.

## 2.07 PERIOD OF MAINTENANCE

A. During the maintenance period of 2 years the Sub-Contractor shall repair and replace directly, at his own expense, any of the plant, material or work performed or furnished under the respective works in the contract which may develop under the conditions provided for by the contract and under proper use in the works or that portion thereof taken over by the Engineer.

B. The Sub-Contractor shall obtain and submit to the Engineer all guarantees or certificates or warranty available from the manufacturers, but only as supplementary to the Sub-Contractor's own liabilities under the contract and in no way invalidate them.

C. The D/G Sub-Contractor shall be fully responsible for the satisfactory operation of the D/G installation during the Maintenance and Guarantee Period. He shall carry out necessary inspection, preventive maintenance and testing to keep the set ready all the time. The set shall function satisfactorily during power failures. The D/G Sub-Contractor shall carry out routine testing of the installation once in every two weeks throughout the maintenance and Guarantee Period. The testing shall be carried in presence of Engineer. The Sub-Contractor shall himself provide all electrical and mechanical spare parts, grease, lubricating oils, touch-up paints etc... required for the maintenance of the D/G installation. The power shall be responsible only for providing diesel oil as and when required. The D/G Sub-Contractor shall prepare log-books listed full details of maintenance work and each log-book entry shall be countersigned by the Engineer.

## 2.08 PROVISIONS FOR BUILDING CONTROL & MANAGEMENT SYSTEM

The Following signal facilities shall be available on the system for interfacing With the building control and management system:

- ATS mode
- Common fault
- High coolant temperature
- Low oil Pressure
- Cranking failure
- Low level daily fuel tank
- Low level underground storage fuel tank

## 2.09 AUTOMATIC TRANSFER SWITCH / ATS/.

The panel for the diesel generator set) shall include:

1. 2 x 4 pole contactors AC1 category, complete with mechanical and electrical interlock and of suitable rating.

2. Phase failure, phase rotation, overvoltage and under voltage unit protection unit with built in adjustable time delay of 0-10Sec.

3. Set of timers for:
   a) delay gen. Loading
   b) delay return of supply.
   c) Delay gen. Start.
   d) Gen. Cool down time.

4. Set of relays for complete automatic transfer function.

5. Three attempts generator start unit, (if not included in the generator control system).

6. Full engine protection to include low oil pressure, high oil temperature, high temperature, low coolant level, engine overspeed, engine under speed, low battery charge. (if not included in the generator control system).

7. Electric jacket water heater with built in thermostat to keep coolant at a constant temperature of at least 50 C.

8. Fully automatic battery charge 15A with automatic trickle/Boost switching.

9. One selector switch with OFF, MAINS, AUTO, TRANSFER position for A.T.S. functions.

10. One set of indication lamps for mains and generator supply and on-load.

11. Complete set of wiring, power and control terminals, labels and documentation for above items.

**12.** European enclosure made from 2mm sheet metal, wall mounted size 2000x1200x400mm W.D.H. floor standing, complete with front door locks and insulation protection degree to IP55.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. **GENERAL**

1. The engine and generator shall be properly aligned and mounted on a common steel base through resilient mountings to prevent vibrations. The whole set shall be fixed on the concrete slabs through suitable number of adjustable spring type vibration isolators. Foundation and other builder's work shall be as recommended by the manufacturer and approved by the Engineer.
2. Except as may be described in this Section or shown on the drawings carry out installation strictly in accordance with the manufacturer's recommendation.

B. Control Boards

1. Run all outgoing cables from the generator to the control boards in the floor trench as indicated on the Drawings.

### 3.02 PAINT WORK

A. Paint work of each set shall be of the highest quality to withstand the worst weather conditions specified. All steel works such as tanks, pipes, frames, louvers, ladders, platforms, etc.. shall be given two undercoats of anti-rust paint and two enamel finishing.

### 3.03 SITE QUALITY CONTROL

A. Final Testing

1. The Engine manufacturer’s qualified representative in the presence of the Engineer shall carry out testing at full load after completion of installation.
2. If the above cannot be done then testing shall be done at the manufacturer/supplier's premises at full load in the presence of the Engineer. All arrangement and costs incurred by such a test shall be responsibility of the Sub-Contractor.

## 3.04 DETAILS OF PROPOSED EQUIPMENTS FOR D/G SET

To be filled and signed by Tenderer and submitted with the offer with supportive engineering catalogues, otherwise the offer may not be considered:

**A** Generating set

| | |
|---|---|
| Generating set Assembler's Name and Address | : ---------- |
| Diesel Engine Manufacturer's Name and Address | : ---------- |
| Type of Engine & Model No. | : ---------- |
| No. Offered Output | : ---------- |
| B.H.P. at N.T.P. | : ---------- |
| Derating Factor | : ---------- |
| No. Of Cylinders | : ---------- |
| Engine Cycle | : ---------- |
| Revolutions - R.P.M | : ---------- |
| Bore x Stroke (mm x mm) | : ---------- |
| Mean Effective Pressure (kg/cm2) | : ---------- |
| Fuel Consumption | |
| At full load g/k W.H. | : ---------- |
| At half load g/k W.H. | : ---------- |
| Lub. Oil temp. at full rated output | : ---------- |
| Design working range of cooling under Specific conditions | : ---------- |
| Jacket water temp..Deg.C | : ---------- |
| Max. Outlet cooling water. temp. From engine at full rated output when air temp.inlet to radiator is 120 Deg.F` | : ---------- |
| Safety control setting of cooling water outlet temperature Deg.C. | : ---------- |
| Type of Governor | : ---------- |
| Weight | : ---------- |
| Engine (Kg) | : ---------- |

Alternator (Kg) : ----------

Complete set (Engine + Alternator + Common bed) (Kg) : ----------

Dimensions

Overall length of set (ft) : ----------

Overall width of set (ft) : ----------

Overall height of set (ft) : ----------

**B. Cooling Water System**

i. Radiator : ----------

Manufacturer's Name and Address : ----------

Location of Radiator : ----------

Tube material : ----------

Fin or fin core mat : ----------

Cooling water outlet temp. Deg.F from radiator at full rated output & worst conditions of 120 Deg.F. air to radiator : ----------

Whether guard screen provided or not ? : ----------

ii Radiator Fan

No. of fans : ----------

Fans size in dia. mm. : ----------

Revolutional speed (r.p.m). : ----------

Air capacity - c.f.m. : ----------

B.H.P. consumed : ----------

iii Circulating Cooling

Water Pump : ----------

Make & Model No. : ----------

Type : ----------

Capacity USG/M : ----------

Head in feet and Permissible r.p.m : ----------

B.H.P. consumed : ----------

Method of drive : ----------

**C. Fuel Daily Service Tanks**

Dimensions -

Height- cms. : ----------

Width - cms. : ----------

Depth - cms. : ----------

Storage capacity gallons : ----------

Material : ----------

**D. Alternator**

Manufacturer's Name & Address. : ----------

Model No. : ----------

Rated voltage : ----------

Rated frequency-Hz. : ----------

Power factor : ----------

Rated output in KVA at N.T.P. : ----------

Rated output in KVA under Jordan conditions (55 Deg.C ambient temperature) : ----------

Rated current amp. : ----------

Efficiency - % : ----------

Speed - r.p.m. : ----------

Type (brush or brushless) : ----------

Class of insulation : ----------

Maximum temp. rise (Deg.C) : ----------

**E. Exciter**

Manufacturer's Name & Address : ----------

| | | |
|---|---|---|
| | A.C. generator of self excited & rotating rectifier | : ---------- |
| | Max. temp. rise Deg.C | : ---------- |
| | Enclosure | : ---------- |
| | Class of insulation | : ---------- |
| | Type of rectifying elements of rectifier | : ---------- |
| **F.** | **A.T.S.** | |
| 1 | Manufacturer's Name and Address | : ---------- |
| | Model No. | : ---------- |
| 2 | Dimensions | : ---------- |
| | Height (cms) | : ---------- |
| | Width (cms) | : ---------- |
| | Depth (cms) | : ---------- |
| 3 | Approx.- Weight (kgs) | : ---------- |
| **G.** | **Type of Automatic Voltage** | |
| | Regulator | : ---------- |
| **H.** | **Starting Battery** | |
| | Manufacturer's Name & Address | : ---------- |
| | Type | : ---------- |
| | Terminal voltage when floating V.DC. | : ---------- |
| | Normal capacity | : ---------- |
| | No. Offered | : ---------- |
| **J.** | **Battery Charger** | |
| | Voltage | : ---------- |
| | No. of Phases | : ---------- |
| | Consumption power at rated output KVA | : ---------- |

**K. Output** **: ----------**

Voltage : ----------

Rated current amp. : ----------

**L. Instruments**

| | |
|---|---|
| Ammeter to read the amp. Of each phase provided | YES/NO |
| Frequency meter provided | YES/NO |
| A/C voltmeter provided | YES/NO |
| Automatic voltage regulator of the self regulating type provided | YES/NO |
| Tachometer scaled in RPM with combined running hour counter provided | YES/NO |
| Visual & audible alarm system for oil pressure provided | YES/NO |
| Visual & audible alarm systems for high cooling water temp. provided. | YES/NO |
| Visual & audible alarm system for over-speed trip provided. | YES/NO |
| Pyrometer with sensing elements and selector switch provided | YES/NO |
| Jacket cooling water inlet thermometer provided. | YES/NO |
| Lubricating oil outlet thermometer provided | YES/NO |
| Other standard gauges, thermometers, etc. provided or not. State What? | YES/NO |

*** END OF SECTION ***

# 16630
# 3 Phases Modular UPS Unit.

## PART 1 GENERAL

This specification describes a continuous duty, solid state, Modular un-interruptible power supply system, module 20KVA expandable to 40KVA OF 10KVA each module, hereafter referred to as the UPS. The UPS shall operate in conjunction with the building electrical system and the generator to provide high quality power for Telecommunication systems. The system shall consist of an inverter, rectifier/battery charger, storage battery, a static bypass transfer switch, synchronizing circuitry and an internal maintenance bypass switch. Cooling fan, inlet dust filter, harmonic filter a radio frequency interference suppression filter at the input and output. The UPS capacity shall be as mentioned in the B.O.Q.

## PART 2 MATERIALS

A. All material and parts comprising the UPS shall be new of current manufacture and shall not have been in prior service.
B. The UPS should be by a reputed manufacturer who is in the industry for a minimum period of 20 years. The equipment must be ISO 9001,ISO14001 certified and manufactured to International standards such as CE,EN/IEC62040 &BS and to meet the requirement of electronic equipment particularly Telecom.
C. Protection Class IP20
D. Audible Noise @ 1 meter 65dBA.

## PART 3 SYSTEMS

The UPS shall be designed to operate as an on-line reserve transfer system, and shall consist of a rectifier/battery charger, batteries, inverter, static bypass transfer switch, synchronizing equipment, protective devices, internal bypass switch and accessories as specified herein that will automatically provide continuity of electric power without interruption, **upon failure or deterioration of the normal power supply. Continuity of electric power to the load shall be maintained for an emergency period with the inverter supplied by**

**the batteries, up to 10 min time or until restoration of the normal power supply**. The operation and control for the UPS shall be provided through the use of microprocessor controlled logic. The system shall provide an alarm indication 10 minutes before the reserve power failure and shall provide automatic shutdown of the non essential equipment at the end of a programmable time.

## PART 4 MODES OF OPERATION

The UPS shall be designed to operate in the following modes:

### 4.01 Normal

The critical load shall be continuously supplied by the inverter. The rectifier/battery charger shall derive power from the utility AC source and supply DC powers to the inverter while simultaneously float charging the battery.

### 4.02 Emergency

Upon failure of the utility AC source the critical load shall be supplied by the inverter, which without any switching, obtains its power from the storage battery. There shall be no interruption to the critical load upon failure or restoration for the utility A/C sources.

### 4.03 Recharge

Upon restoration of the utility AC source, the rectifier/battery charger powers the inverter and simultaneously recharges the battery. This shall be on automatic function and shall cause no interruption to the critical load.

### 4.04 Bypass Mode

If the UPS must be taken out of service for maintenance or repair of internal failures or in cases of heavy output overload, "the static bypass transfer switch" transfers the load to the alternate source without an interruption. Retransfer to the load shall be accomplished after the UPS inverter automatically synchronizes to the alternative bypass source.

Once the source is synchronized, the static bypass transfer switch shall transfer the load from the by-pass source to the UPS inverter to ramp into the load and then disconnecting the bypass input source.

### 4.05 Maintenance Bypass/Test Mode

Internal switches shall be provided to isolate the UPS inverter output and static bypass transfer switch output from the AC bypass input source and the load. The switches shall enable the UPS inverter and static bypass transfer switch to be tested without effecting load operation.

### 4.06 Downgrade

If the battery only is to be taken out of service for maintenance, it shall be disconnected from the rectifier/battery charger and inverter by means of a circuit breaker. The UPS shall continue to function as specified.

### 4.07 UPS System Rating

The UPS system shall be as shown on drawings at rated voltage, for a minimum autonomy of 10 minutes for the computer equipment.
The UPS shall be able to supply 125% rated load for at least 10 minutes.

### 4.08 Electrical Characteristics:

Input Rectifier
a. Voltage : 3Ph + N400 / 230V
b. Tolerance ± 20%
c. Frequency : 50Hz ± 5% (Auto Sensing)
d. Input power factor correction

### 4.09 Output Inverter

a. Voltage : 3Ph + N400 / 230V
b. Tolerance stable condition ± 1.5%
c. Overall harmonic distortion on linear load: <1%
d. Phase angle accuracy for 100% unbalanced load ± 2%
e. Frequency: synchronize to mains (47-53 HZ for 50 HZ nominated)
f. Free running output frequency accuracy ± 0.01%

g. Acceptable load power factor: 0.9 lag to 1
h. Acceptable overload:
   60 sec : 150%
   1 h : 110%
i. Acceptable crest factor without downgrading: Unlimited
j. Overall efficiency: up to 94%

### 4.10 Rectifier/Battery Charger

Incoming AC power shall be converted to regulated DC output by the rectifier/battery charger. A phase controlled bridge rectifier shall provide regulated DC voltage which is subsequently filtered to provide power for the inverter and battery charging functions. The battery charging circuitry shall be capable of being set for automatic battery recharge operation, float service, manual battery charge service and equalize operation.

The rectifier/battery charger shall have sufficient capacity to support a fully loaded inverter and recharge the battery to 95% of its full nominal capacity within 24 hours.

The charging current shall be automatically limited by an electronic device to a maximum value as specified by the battery manufacturer. Charger regulation shall ensure DC output fluctuation is less than 1% of the DC voltage.

### 4.10 Battery

A. The Battery shall be of sealed lead acid type.
B. The Battery to be UL approved for UL standard (UL 924).
C. The Battery must carry a life time of 10 years.
D. The Batteries to be installed in separate stands or racks.
**E. The backup time for the batteries will be normal time 10-15min.**

Battery Specifications:

- High conductivity connectors & terminals.
- High Integrity pillar seal.
- Self regulating relief valve.
- Rugged super-thick positive plates.
- Balanced negative plates.
- Tough flame retardant cell box ( Thick Wall VO rated ABS)

- Low Resistance microporous glass fiber as a separator (The electrolyte is absorbed within this material )
- Each battery shall provided with molded lifting handles.

### 4.11 System Status and Control

The UPS shall be provided with a system status and control panel to provide monitoring and control of the complete system. The UPS shall be equipped with a self test system identifying the faulty subassembly in the event of a problem. Indications, measurements and alarms together with power history and battery autonomy shall be shown on LCD panel.

Other Required Specifications:

- Intelligent Battery management.
- Manageable external batteries.
- Network manageable (Over LAN) Programmable frequency.
- Software license & UPS original documents

### 4.11 System Status and Control (cont'd)

**A. Metering**

A meter shall be provided with the capability of monitoring any of the following system functions:

a. AC output voltage (L-L).
b. AC output current/phase (L-N).
c. AC output frequency.
d. DC voltage.
e. Battery DC current (Charge/discharge).

**B. System Control**

The following controls shall be provided for the system:
a. Inverter off push button.
b. Lamp test push button.

**C. System Alarm**

Visual Alarms: The following status shall be signaled:
a. Rectifier-charger in operation.
b. Load on inverter.

c. Load on standby mains.
d. General Alarm.

**D.** Also the following signaling shall be available.

a. Battery problem.
b. Manual charging cycle running.
c. End of battery autonomy.
d. Manual bypass in maintenance position.
e. Standby mains outside tolerance limits.

## PART 5 Submittals:

- Catalog & Documents for the UPS & Batteries.
- Certifications.
- Recommended spare parts.
- Delivery Period.
- Manufacturer Training for 1 trainee.
- Warranty for 2 years.

# EARTHING

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Grounding System including, but not limited to the following:

1. Grounding rods.
2. Grounding conductors.
3. Grounding connection bar.
4. Grounding of various systems.

### 1.02 RELATED SECTIONS

A. Electrical Works, General.

B. Electrical Identification.

C. LV Cables and Wires.

D. Underground Electrical Services.

### 1.03 REFERENCES

A. British Standard Code of Practice CP1013 - Grounding.

B. BS 7671 IEE Wiring Regulations, 16th Edition.

## 1.04 SUBMITTALS

A. Submit manufacturer's data, illustrated leaflets, dimensions, fixing details and description of the proposed products.

## 1.05 QUALITY ASSURANCE

A. Manufacturer's: Firms regularly engaged in the manufacture of Grounding equipment, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and suppliers/agents.

B. All equipment furnished under these Specifications shall conform to the requirements of BS, IEC and Local Standards Organization.

## 1.06 DELIVERY, STORAGE AND HANDLING

All products shall be carefully packed to avoid damage during transportation.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. All the materials required for Grounding system shall be furnished new and undamaged in accordance with the requirement stated in this section.

B. Conduct soil electrical resistively tests at four locations (minimum) advised by the Engineer. The Grounding calculations based on the test results shall be submitted for Engineers approval, to demonstrate that the proposed design of Grounding system complies with the specifications and standards.

C. For High voltage equipment in Transformer room, a connection shall be provided from the main Grounding loop. Also Grounding pits shall be installed as per Local Electric Supplier requirements, which will be isolated from the main Grounding loop.

D. For communication room, separate Grounding pits shall be installed as per Local Telephone Supplier requirements, which will be isolated from the main Grounding loop.

### 2.02 Grounding connection bar

A. For connection of MV and LV equipment, sub-station shall have high conductivity copper, Grounding connection bar with minimum dimensions of 50 x 6 mm and mounted on porcelain insulators. The bar shall be of suitable length with pre-drilled holes at a minimum distance of 50 mm between hole centres.

B. Grounding connection bars for transformer neutral and LV switchboard frame shall be separate from Grounding bar for HV and transformer frame.

C. Each Grounding connection bar shall have a permanent label to identify the connections together with the wording "Main Grounding Bar".

## PART 3 EXECUTION

### 3.01 INSPECTION

A. Examine the area and conditions under which the Grounding systems are to be installed and correct any unsatisfactory conditions detrimental to the timely and proper completion of the work. Do not proceed with the work until the conditions are satisfactory in a manner acceptable to the Engineer.

### 3.02 GROUNDING CONDUCTORS INSTALLATION

A. Standard sizes of stranded copper conductor used for Grounding continuity shall be according to the requirements of IEE Wiring Regulations, 16th Edition..

B. Suitable Grounding facilities, acceptable to the Engineer, shall be furnished on electrical equipment to consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

C. The conduit system shall not be considered as continuous for Grounding purposes. A separate Grounding conductor shall be installed in the same conduit with the phase and neutral conductors. The separate Grounding conductors shall be sized according to IEE Wiring Regulations, 16th Edition. requirements. No Grounding conductors shall be smaller than 2.5 mm2 unless this is part of a multicore cable. Where flexible connections are made to equipment, Grounding jumpers shall be provided. All connections of heavy gauge steel conduit system shall be checked for good electrical continuity.

D. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to the dominant surface.

E. Conductors routed over concrete, steel or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not exceeding 1 m.

F. Exposed Grounding conductors shall be securely fastened to the mounting surface using copper or brass straps.

G. Clamps, connectors, bolts, washers, nuts and other hardware for bolted connection to Grounding system shall be of copper.

H. Exothermic welds shall comprise moulds, cartridges, materials, and accessories as recommended by the manufacturer.

I. The Grounding conductors entering the building shall be installed in a 25 mm diameter PVC conduit. Waterproofing shall be provided at all entry of Grounding conductors, details of which shall be approved by the structural engineer.

J. Grounding conductors shall be buried at a minimum depth of 750 mm below finished grade.

K. Underground conductors shall be buried in clean sifted Grounding.

L. Except for sub-stations and electric rooms, the exposed Grounding conductor shall run in protective pipes for runs below 900 mm from floor level. Pipe shall also be provided at locations where conduct is likely to be subject to physical damage.

M. Extensions from Grounding loop as shown on the Drawings shall be provided for connection to electrical equipment. Connect the Grounding conductor to the equipment, Grounding bus, pad or lug. In addition to the Grounding grid extension conductors, an Grounding cable to each end of the Grounding bus in each assembly of power distribution board or panel boards shall be provided.

N. Where an Grounding conductor is included with the phase conductors of power circuits, the Grounding conductor shall be connected to the equipment Grounding facilities and to the source Grounding bus. Where an grounding conductor is not included with the phase conductors, the equipment shall be Grounded by connecting a separate Grounding cable to the equipment Grounding facilities and to the tray Grounding cable or source Grounding bus. Except where otherwise shown on the Drawings, integral parts of a cable assembly shall be sized in accordance with the requirements of IEE Wiring Regulations, 16th Edition.

## 3.03 BUILDING SYSTEMS GROUNDING

A. The building low current systems including communication, control and alarm functions…etc shall be provided with Grounding as shown on the Drawings and in relevant specifications.

B. The installation of the Grounding for building systems shall be in accordance with the recommendations of standards, and the applicable provisions of this section.

## 3.04 SUPPLEMENTARY AND EQUI-POTENTIAL BONDING

A. In accordance with Section 547 of the IEE Wiring Regulations 16th edition (BS 7671) bonding conductors shall be installed in appropriate locations to ensure all simultaneously accessible exposed or extraneous conductive parts are at equal potential. Undertake such tests and install such supplementary bonding conductors that are necessary to ensure compliance with these requirements.

B. Supplementary bonding conductors shall conform to the requirements of Section 547-03 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 2.5 mm2 where mechanically protected and 4.0 mm2 where not so protected.

C. Main equi-potential bonding conductors shall conform to the requirements of Section 547-2 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 6.0 mm2.

## 3.08 FIELD QUALITY CONTROL

A. Grounding resistance tests shall be carried out after installation of the individual Grounding systems in accordance with the Specifications. The Grounding resistance tests shall be carried out in accordance with Section 713-11 of the IEE Wiring Regulations 16th edition and readings obtained officially recorded by all witnessing parties.

C. Prior to connection of Grounding rods to the Grounding system, the Grounding resistance of individual Grounding rod shall be measured by using an approved type of Grounding resistance tester.

D. After completion of all the connections of Grounding system, the Grounding resistance shall be measured from the Grounding test point in presence of the Engineer.

E. All the Grounding resistance test reports shall be submitted for Engineer's approval.

The presence of the electrode shall be indicated in English and Arabic.

****** END OF SECTION ******

# DATA SYSTEM

## PART 1 GENERAL

### 1.01 GENERAL

A The data System shall comprise of Supply, installation, testing & documentation for a category 6A cabling for the mentioned project provisional.

B Separate raceways shall be used for the data system.

C All runs of raceways shall be accessible for modifications or maintenance.

D Any additional ductwork, encasement works /raceways required shall be the responsibility of the electrical contractor. He shall not be entitled for any additional claims on these accounts.

E It is assumed that the contractor before signing the contract has surveyed the site and ascertained the routes and hurdles.

F The certified installer will be fully responsible on quality of service and warranty certificate to be submitted directly for the contractor under engineer supervision.

### 1.02 SCOPE OF WORK

*The contractor shall supply, install and commission as provisional items first fix of the data System as ONE package, having the following as a minimum:*

- Computer cabling cabinets
- Data Outlet with RJ45 Sockets Category 6A/type 3M
- Category 6A cables
- Raceways, trunking, conduits etc
- All other components, accessories required to complete the first fix Data system.

Not all the mentioned items specified in the specification are required in the contract, some items shall be submitted and installed by others, refer to B.O.Q. for included items.

## 1.03 CONTRACTOR OBLIGATIONS & QUALIFICATIONS:

The contractor shall carefully examine all of the specifications to ensure that he is fully conversant therewith & has included for everything necessary therein, either expressly provided for or as would normally be expected to be provided for by a reputable specializing in the type & nature of the services Described In The Contract.

The contractor is advised that items or matters not specifically provided for, or partially described or otherwise missing from the specifications, but which are nevertheless necessary for the execution & completion of the services, shall be deemed to have been included by the contractor.

Authorized & certified installers registered with their respective manufacturers with trained & certified engineers shall execute the installation of the cabling system.

The contractor shall carry out all the necessary surveys, design & engineering so as to provide for the services, a whole & complete system to ensure full compatibility of the services with any existing facilities pertinent to the cabling system applications/operations.

The scope of the services include the provision of all material, labor, supervision, construction, equipment, tools, temporary, spares, consumable & all other things & services required to engineer, design, supply, install, test & commission the cabling system.

## 1.04 EQUIPMENT & MATERIAL

All equipment, material & the like shall be such so as to withstand the prevailing climatic conditions in the state of Jordan & within the parameters of an ambient temperature varying from zero (0) to plus fifty five (55) degrees centigrade & a maximum relative humidity of one hundred percent (100%).

## 1.05 TESTING & COMMISSIONING

Acceptance testing shall be carried out by the contractor & witnessed by the owner personnel. The contractor shall provide all necessary instruments & accessories required to perform the testing.

## 1.06 WARRANTY

The system supplier shall warrant to repair or replace & make good at its expense any material found defective during a period of fifteen years from the date of the acceptance certificate.

## 1.07 RELATED SECTIONS

| | | |
|---|---|---|
| A. | Section 16110 | Raceways |
| **B.** | **Section 16120** | **Conduits** |
| C. | Section 16300 | Supporting devices |
| D. | Section 16200 | Cables & wires |

**1.08 The specification and BOQ for the data system are for the guidelines of the contractor for the purpose of bidding. The contractor shall include all material and devices though not indicated but required for the proper and efficient installation of the system.**

# PART 2 PRODUCT

## 2.01 DATA BACKBONE

Technical specifications:

### 2.1.1 FTP CAT6A (4 PAIRS) CABLES

Installation cables category 6A, Enhanced, FTP
The pair-shielded 100ohm installation cables are suitable for voice, and data transmission at frequencies of up to 250 MHz. Dimensions: 4 x 2 x 0.58mm.

Cable construction

| Sheath | Color | Conductor | Insulation |
|---|---|---|---|
| Material | | Diameter (mm) | Diameter (mm) |
| LSOH | Grey, RAL 7035 | 0.58 | 1.04 PE |

Cable Properties

***Bending***

***Minimum bending radius, installation 8 x D***

Minimum bending radius, installed 4 x D

Tensile Strength

Maximum tensile load, installation (N) 100

Maximum tensile load, installed No stretch

Temperature Range

*Operation (ºC) –20 to +60*

**Installation (ºC) 0 to +50**

Fire Classifications:

PVC : IEC 60332-1

LSOH: IEC 61034, IEC 60754-1, IEC 60332-1

Heat Release

LSOH (MJ/km) 1030

Electrical characteristics 20 C

Characteristic impedance (4<f<100 MHz):100±15

DC-loop resistance (Ί/km)

Resistance unbalanced, max (%)2
Optical braid overage (%)41
Transfer impedance, IEC 96-1
1 MHz (Ω/m) 5
10 MHz (Ω/m) 10
Nominal velocity of propagation (NVP)c 0.75
Mutual capacitance, nominal (pF/m) 48
Capacitance unbalanced, max. (pF/m) 1000

### 2.1.2 FTP RJ45/3M CONNECTION MODULES (FOR DATA)

The Cat. 6A connection modules are the connection modules that comply with the latest standard proposals of the international standardization bodies. They are the center piece in the realization of class E channels with up to 4 connection modules. Comply with the cat.6A components requirements of the latest standard proposals of ISO/IEC.

- Conform to Cat.6 requirements according to the EIA/TIA.
- 10dB better Next values with 100MHz
- Best transmission properties with freenet Cat.6 patch cords (R302298-R302341)
- Backwards compatible with Cat.5e and Cat.5.
- Fits into all freenet patch panels and outlets.
- Tool-free connection technique (IDC) for data cables with AWG 22-24 wire diameter.
- Allows opto-mechanical control of the connection technique.
- Error-free connection according to EIA/TIA 568A/B without pair crossover thanks to labeled wiring.
- Simple and time-saving shield contacting with integrated cable strain relief.
- Halogen-free material.
- 3P,UL,cUL certified
- Certificates available.

**Electric and Transmission Data**
Contact resistance < 50 milliohm (conductor - conductor)

Contact resistance < 20 milliohm (shield - shield)
Insulation resistance > 500 mega ohm (500 VDC)
Dielectric strength 1000 Veff. 50 Hz/1 min (conductor - conductor)
Dielectric strength 1500 Veff, 50 Hz/1 min (conductor - shield)
Coupling resistance IEC 96-1
1 MHz < 15 milliohm
10MHz< 100 milliohm

**Mechanical Data**
Material Polycarbonate, (UL 94V-0)
Mating cycles > 1000
Wire diameter 0.5 mm (AWG 24} - 0.65 mm (AWG 22)
Insulation diameter 0.8 - 1.6 mm
Mating cycles > 100
Wire strain relief Through labyrinth in IDC block
Cable strain relief Through cable ties
Shield contacting 1
Large surface contact springs (on plug)

### 2.1.3 DUAL FACE PLATES:

The free net dual modular outlets (voice/Data) and connection modules combine in various ways. The outlets accommodate a vast range of modules:
For optical wave guides, RJ45. ISDN or analogue telephony. The modules can be linked together in a single outlet and exchanged simply without any need for tools.
To ensure a clearer distinction, individual outlets at the workstation and on the Global Rack can be mechanically and color coded.
For greater safety in the event of fire, plastic outlets manufactured to fire category VO. Cat. 5e can be fitted to Cat. 6A
Modules on the same outlet, ensuring an easy switch to a higher category - another free net plus!

### 2.1.4 TRUNKS

Plastic trunks with different sizes should contain all the exposed cabling installation (if any).

## PART 3 EXECUTION

**3.1** All installation work shall be as per Data Transmission rules and regulations. Where no regulation is available, IEE wiring regulation shall be followed.

**3.2** The maximum horizontal portion of a cabling system from work area information outlet to a mechanical termination at the patch-panel in the wiring closets must not be more than 90 meters, the cable run must be free of bridges, taps & splices. Cabling shall be as per ISO /IEC IS11801 Standards.

**3.3** Cables shall be of one continuous length. No joints are to be introduced in any circuit starting from work area outlet to a mechanical termination at the patch panels in the wiring closets.

**3.4** Cables shall be laid with bend radii and maximum pull through forces as per manufacturer's standards.

**3.5** Conduit and ceiling distribution shall be according to EIA/TIA 569 standards

**3.6** Drawing and specification are complementary each to the other.

**3.7** Shall co-ordinate with other trades for the installation of the system.

**3.8** The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.

**3.9** Outlets shall be atleast 25cm distance from nearest electrical point.

**3.10** Nodes shall be tested using scanner for category 6 outlets. The test shall be performed in the presence of the engineer after termination.

**3.11** Both ends of the cable shall be labeled for identification.

**3.12** Detailed cable routing diagram must be produced for installation. This shall be reference for future maintenance, expansion, fault tracing etc.

**3.13** Contractor shall provide a full set of manuals and operating instructions. It shall include descriptive brochures, technical manuals for all equipments forming part of the contract.

***** END OF SECTION *****

# SECTION-16800 - APPROVED MANUFACTURER LIST

| Material | | Manufacturer |
|---|---|---|
| Main Distribution Boards | a) | Merlin Gerin (France) |
| | b) | Moeller (Germany) |
| | c) | ABB (Europe) |
| Instruments and Meters | a) | Satec (Locally) |
| | b) | ABB (Europe) |
| Sub-main Distribution Boards | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller (Germany) |
| . Distribution Boards | a) | Merlin Gerin (France) |
| | b) | ABB (Europe) |
| | c) | Moeller (Germany) |
| Disconnecting Switches | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller |
| Lighting Contactors | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller(Germany) |
| Motor Control Panels | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller(Germany) |
| Relays for Remote Switching | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller (Germany) |

| | | |
|---|---|---|
| Wires and Cables Lighting and Power,and Low voltage(FA,PAVA,..) | a) | SYNERGY(locally) |
| DATA - Structural Cables and Accessories | a) | CAT6A 3M,R&M,DATWYLER |
| Sockets and patch panels | b) | RJ45/3M, R&M DATWYLER |
| | c) | 24PORT P.P/3M –R&M DATWYLER |
| Cable Trays and Ladders | a) | OBO beterman (Germeny) |
| | b) | Nidax (Germeny) |
| Metallic Cable Trunking | a) | Locally/according to engineer approval |
| Capacitor Banks | a) | EKG (Germeny) |
| | b) | Simens (Germeny) |
| Motors and Starters | a) | Moeller (Germany) |
| | b) | Telemecanique (France) |
| PVC Conduits and Fittings | a) | Locally/according to engineer approval |
| PVC Flexible Conduits | a) | Locally/according to engineer approval |
| Boxes | a) | Legrand(France) |
| Cable Glands & Accessories | a) | BICC (UK)/or approved equal |
| Lighting Fixtures | a) | as per lighting fixtures schedule or equal |
| Wiring Devices & Accessories | a) | Legrand (France),Vimar |

(White)

| | | |
|---|---|---|
| Fire Alarm System-Analogue/ Addressible(UL) | a) | Notifier (USA) |
| | b) | Simplex (USA) |
| | c) | Edwards (Canada) |
| Lightning System | a) | Furse (UK) |
| | b) | Helita pulsar (France) |
| Earthing System | a) | Locally/according to engineer approval |
| | b) | Locally/according to local authority approval |
| Builders work | a) | Locally/according to engineer approval |
| ACCESS CONTROL | a) | GE or equal(enterprise) |
| | b) | HONYWEL |
| (Public Address & Voice Alarm (PAVA) | a) | TOA (Japan) |
| | b) | BOSCH (Holland) |
| CCTV (UL) | a) | AXIS |
| | b) | BOSCH (Holland) |
| | a) | PELCO |
| UPS DEVICES | a) | APC/USA |
| | b) | MG/France |
| GENERATOR CLASS2 LOW EMMESION | a) | CATERPILLAR |
| | b) | FG-WILSON |
| | a) | SDMO |

***** END OF SECTION *****