

Section 16010 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. DIN German Institute for Standardization
(Deutsches Intitut fur normung)
 7. Municipality Regulations.
 8. 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 labour 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 based 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 wireways, 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 13800 Volts, $\pm 5\%$, 3 phase, 50Hz. The interface with the utility company incoming supply is the local power supply authority 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

2.01 General

- A. All goods and products covered by these specifications shall, when available, be procured from approved manufacturer. Procurement of all goods and products manufactured out-of-the approved list must be approved by the Supervising Engineer.

- B. 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 present 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 a standard finish paint, shall be cleaned and given one shop coat of a 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 manufacturer's 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 General:

1. Where bolted connections are made to aluminium 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 wrenches. Torque wrenches 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 to the 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 ampacities. 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 panelboard, pertinent branch circuit panelboard, 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*****

SECTION 16120 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

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 authorities as 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.
- A. Where plenum is used for return air, steel (GI) conduits shall be used**
- 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 *****

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 2. Ceiling roses.
 3. Fan coil power outlet / fused connection unit.
 4. Pendant cord / connection device.
 5. Snap switches
 6. Grid switch assemblies
 7. Timer switches.
 8. Lighting contactor push buttons.
 9. Fan speed controls.
 10. Communications outlets.
 11. Wall plates.
 12. Control stations.
 13. Fireman's emergency switch
 14. Cable outlets.
 15. Hand dryers.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.

- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Comply with:
 1. BS 3676 Pt.1 :1989, BS EN60947-3 for lighting switches,
 2. BS1363 Pt.2:1995, BS 4343, 546 and 196 for Socket Outlets and plugs.
 3. BS 1363 Pt 4:1995 for connection units DP Switches.
 4. BS 5733: 1995 for grid switches.
 5. BS 6972, 6141 and 5733 for ceiling roses

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one manufacturer with minimum experience five years.

2.2 GFCI RECEPTACLES

- A. General Description: Straight blade, feed through type, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 240 V, 20 A.

2.3 SOCKET OUTLETS

- A. Socket outlets shall be mounted with correct polarity, such that switch shall cut the hot wire.
- B. Socket outlets shall be of the standard, 3-pin, switched, single phase, shuttered type of molded plastic unless otherwise specified.
- C. 13-amp socket outlets shall be flat pin type, to BS 1363, single or twin as indicated. 15-amp socket shall be round pin switched type to BS 546.

2.4 PROTECTIVE SOCKET COVER

- A. Weatherproof socket outlets shall be provided with protective socket covers.
- B. Protective socket cover shall be manufactured from high impact resistant “Noryl”. The cover shall be designed to fall by gravity over the socket whether a plug is inserted or not.

2.5 CEILING ROSES

- A. Ceiling roses shall be designed to meet the requirements for the installation of flexible pendent cords for lighting. They shall be molded in a non-track insulating material to BS 6972, 5733 and 6141 and shall be 3 pin plug in ceiling roses.
- B. Ceiling roses shall incorporate 3 terminals (one of which properly shrouded), loop-in, earth and strain. The shrouded terminal shall be used for the live un-switched wires.
- C. All lighting fixtures incorporated in a false ceiling shall be connected to the ceiling lighting outlet through a ceiling rose and a flexible cord

2.6 FAN COIL POWER OUTLET / FUSED CONNECTION UNIT

- A. Power outlets for fan coil units ceiling mounted shall be flush surface mounting 13-amp fused connection units incorporating double pole switch, neon indicator and fuse of appropriate rating, in a 2-gang device box, with the second gang covered with a blank plate.
- B. Outlet for fan coil units with heaters ceiling mounted shall be surface mounting type and shall comprise a 20-amp double pole switch for the fan motor and a 50-amp double pole switch for the heater.
- C. Outlet for fan coil units installed at low level shall be a recess mounting 13-amp fused connection unit incorporating a double pole switch, neon indicator, fuse of appropriate rating and flex outlet.
- D. Outlet for fan coil units with heaters installed at low level shall be a recess mounting 25-amp twin double pole switch with two flex outlets or alternatively a 20-amp and a 50-amp two double pole switches with two flex outlets.

2.7 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 SNAP SWITCHES

- A. Switches shall be rocker operated mounted with the operating handle in the upward position when the “ON” position unless otherwise directed.
- B. Switches shall interrupt the hot wire or hot and neutral simultaneously as applicable.

- C. Switches shall be quick-make, quick-break, with silver alloy contacts, trunnions and spring assembly lubricated for the life of the switch neoprene bumpers.
 - D. Lighting Switches shall be 250 V ac only, 10 A rating to BS 3676 Part 1.
 - E. Switches shall be fully rated for tungsten filament and fluorescent lamp loads, and up to 80% of rated capacity for motor loads.
 - F. Switches shall be one gang or multigang, 1-way, 2-way or intermediate as indicated on the drawings and to the approval of the Engineer.
 - G. Key operated lighting switch shall be 20 amp rated, one way single pole. 20-Amp double pole switches shall incorporate a pilot light, and shall have the words "Water Heater" engraved on it when used for that propose.
 - H. 30-Amp double pole switch shall incorporate the inscription indicating the purpose of its use.
 - I. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 250 V, 20 A; for use with mechanically held lighting contactors.
- 2.9 GRID SWITCH ASSEMBLIES
- A. Switch assemblies shall be of the grid switch system, comprising rocker-operated grid switches and cover plates of molded material with white finish, unless otherwise indicated.
 - B. Switch assemblies shall comprise 20-amp lighting switches, and other units if so indicated on the Drawings.
 - C. Switch assemblies shall have the words "Danger 400 volts" engraved in red in it.
- 2.10 TIMER SWITCHES
- A. Timer switches shall be 20-amp rated, one pole, one throw with one "OFF" and one "ON" levers. Switch shall be 30 minute dial type, recess mounted. Switches shall have 20,000 switching cycles guaranteed life.
- 2.11 LIGHTING CONTACTOR PUSH BUTTON
- A. Pushbuttons shall be double contact type with spring return action.
 - B. Body shall be made of molded plastic with clear baked acrylic protection.
- 2.12 FAN SPEED CONTROLS
- A. Modular, 240-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
- 2.13 COMMUNICATIONS OUTLETS
- A. Telephone Outlets: Telephone outlets shall be RJ11 type and shall consist of terminal blocks of high insulating phenolic block with non-ferrous screws and straps.

2.14 WALL PLATES

- A. Plates shall be rectangular or square in shape to the approval of the Engineer.
- B. Plates shall be designed to match associated devices.
- C. Plates for cord extension shall be provided with cord grip bushings, threaded type, of same material and finish as of plate.
- D. Unless otherwise specified or indicated on the Drawings, plates for flush mounting devices shall be constructed of molded material of ivory or white in color.
- E. Fixing screws shall be chromium plated and polished. Screw heads shall be finished to suit the plates.
- F. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, with lockable cover.

2.15 CONTROL STATIONS

- A. Control stations shall be spring type, with silver plated contacts. Contacts shall be 5 amp rated. Plate shall be constructed from aluminum gray baked enamel painted.
- B. ON-OFF maintained contact station shall have two pushbuttons, one green for ON and one red for OFF. A green pilot light shall be incorporated which shall lit when pushbutton ON is depressed. The words ON & OFF shall be engraved on the pushbuttons in white.
- C. START-STOP momentary contact type station shall have two pushbuttons, one green for START and one red for STOP. A green pilot light shall be incorporated which shall lit when pushbutton START is depressed. The word START & STOP shall be engraved on all motor control stations.
- D. UP-STOP-DOWN momentary contact type stations shall have three pushbuttons and no pilot lights.
- E. Pushbuttons shall be molded from trac-resistant material, and shall be provided with button shrouding ring.
- F. Key switch shall be a cylinder lock operator type station with three positions UP-OFF-DOWN. These words shall be engraved on the station.
- G. Stations in damp & wet locations shall be enclosed in a Ferroalloy box and covered with stainless steel plates.
- H. When line voltage is 380-415 and the control is line-to-line connected as described under MOTORS & STARTERS", a warning notice shall be inscribed in the device in a clearly visible manner once the cover is removed.

2.16 CABLE OUTLET

- A. Cable outlet shall comprise a molded cover plate with a side groove for 3 x 10 mm² multi-core flexible cord, a cable clamp, 3 terminals for 10 mm² conductors.
- B. Cable outlet shall be similar to Crabtree 4506, MK 5045 to the approval of the Engineer.

2.17 FIREMAN EMERGENCY SWITCH

- A. Fireman's emergency switch shall be 16 Amp double-pole or four pole as applicable. It shall incorporate a neon light. Opening of cover shall not be possible when live.
- B. It shall be protected against dust and splash of water to IP54.

2.18 HAND DRYER

- A. The hand dryer should be wall mounted type, controlled by infrared proximity switch, without touch ON/OFF switch, constructed from sturdy impact resistant case of high grade ABS, where motor fan and heater elements are rated for many years of maintenance free services. The unit should be fitted with integrated mounting plate, safety mains plug connection, safety temperature limiter, sensor controlled safety switch and thermal fusible cut-out. The rated power should be not less than 1800w, where heating power not less than 1700w, motor power 100w and air volume not less than 38l/s.

2.19 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: Ivory or White, unless otherwise indicated or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than 150 mm in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. Provide device plates for each outlet of the type required for service and device involved.
- G. Ganged Devices. Mount ganged devices under a single, one-piece, device plate. Engrave plates with 3mm-high black letters, if designated for engraving.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. The engineer reserves the right to make any reasonable changes in outlet locations without change in the contract sum.
- 3.2 IDENTIFICATION
- A. Comply with Division 16 Section "Electrical Identification."
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- 3.3 FIELD QUALITY CONTROL
- A. Perform tests and inspections and prepare test reports.
- B. Tests for Convenience Receptacles:
1. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest.

END OF SECTION 16140

SECTION - 16200 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.

All cables and wires which are used for power emergency circuits should be fire rated according to NFPA.

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.

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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 authority's 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 lying, 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. Armored 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

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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. Armored 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, and 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

2.06 Cable with functional endurance

Low voltage cable 0,6/1kV according DIN VDE 0266,
DIN VDE 0207 Part 24, HI1 flame resistant, colour orange,
NHXCHX E30 (dimensions of the cable as shown on drawings and

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BOQ)

Kind of mounting: on existing cable trays, rising trays, individual with cable holders, according DIN 4102 part 12.

PART 3 – EXECUTION

3.1 GENERAL

Cables/wires shall be installed as per the concerned local authority's regulations. Where no concerned local authority's 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 *****

SECTION 16400 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	Busbar & 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 & controlgear 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 16640	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 electrogalvanized 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 vapour 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, busbars, 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 fully type tested (TTA) 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 Busbars 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 busbars 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 be removable by tool or special key.
- C. The busbars shall be made of electrolytic, hard drawn high conductivity flat pure tinned copper bars complying with IEC Standard. The whole busbar system shall comply fully with the requirement of latest IEC standards.
- D. The busbars shall be air insulated and shall be rigidly supported on purpose made insulators of non-hygroscopic glass fibre mouldings 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 busbars shall be provided with coloured PVC sleeveings at regular intervals for phase identification.

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 $I_{cs}=I_{cu}=I_{cw}$ 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 millise in steps of 100 millise.
- 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 up to 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 moulded 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 multipole breaker. Moulded 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 A²s for ratings upto 250A and 5×10^6 A² s for ratings above upto 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.
Main distribution board (MDB or MLTP) should be form 4b construction; sub main distribution board (SMDB) should be also form 4b construction.

- 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 IEC 947-2 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 6 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 380V, 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 as 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 CONTACTORS

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 220V 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 220V 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 380V 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., 380V, 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 380V 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 VFD (Variable Frequency Drive)

Refer to (mechanical) for full specifications and interface with the BMS.

2.17 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 \pm 15% at 50Hz
Output	415V AC \pm 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 2.5mm² 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

*** E ND OF SECTION ***

PART 1 GENERAL REQUIREMENTS

A. General:

- Standards

- Illuminating Engineering Society (IES):

LM-79-08.....Electrical and Photometric Measurements of Solid-State Lighting Products

LM-80-08.....Measuring Lumen Maintenance of LED Light Sources

LM-82-12.....Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature.

B. QUALITY ASSURANCE:

- Acceptable Manufacturers.

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.

PART 2-PRODUCTS

2.1 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%.

2.2 Equipment

FB architects Engineer

- 1.Luminaires shall be completely self contained, 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°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°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.

2.3 Submittals

- A. 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.

B. Samples and shop testing.

Fixture (Recessed type)

- i. For the lighting fixture (recessed in F.C) the contractor shall obtain from the 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 coordinated 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.

2.4 LED Luminaires

1. LED Lights shall be in accordance with legend .
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
 - a. Minimum efficiency: 90% at full load.
 - b. Minimum Operating Ambient Temperature: -20° C.
 - c. Input Voltage: 220- 380V at 50 Hz.
 - d. Integral short circuit, open circuit, and overload protection.
 - e. Power Factor: ≥ 0.95 .
 - f. Total Harmonic Distortion: $\leq 20\%$.
 - g. Comply with FCC 47 CFR Part 15.
4. LED modules shall include the following features unless otherwise indicated:
 - a. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
 - b. Minimum CRI 90 and color temperature 4000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE or legend .

- c. Minimum Rated Life: 55,000 hours per IES L70.
 - d. Light output lumens: >90 lumen/watt.
 - e. All lighting shall be (MACADAM 2)
5. The LED system shall be capable of at least 8-bit control of red, green and blue LEDs to produce 16.7 million colors or more.
6. The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
7. High power LED fixture shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.
8. For wet and damp use, LED-based fixture itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure.
9. LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.
10. All hardwired connections to LED fixtures shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
11. All LED fixtures and power supplies shall be provided by a single manufacturer to ensure compatibility.
12. All products associated with installation and control of the LED system, including peripheral devices and software are to be provided by a single manufacturer.
13. Power supply outputs shall have current limiting protection.
14. Power supply shall provide miswiring protection.
15. Power supply shall have power factor correction.
16. Power supply shall provide connections that are conduit-ready or clamp-style connections for the low-voltage wiring.
17. Power supply shall come with a housing that meets a minimum IP20 rating for dry location installation

18. All LEDs used in the LED fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
19. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.
20. LED fixture shall be UL listed or UL classified.
21. LED fixture shall be CE certified.
22. LED fixtures shall be PSE marked.
23. Power supply shall be UL listed for Class 1 or Class 2 wiring
24. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.
25. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
26. All LED fixtures (100% of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.
27. Manufacturer shall provide optical performance, polar diagrams, and relevant luminance and luminance photometric data based on test results from an independent testing lab.
28. Manufacturer shall provide photometric data in IES file format in accordance with IES LM-63-2002, based on test results from an independent testing lab.
29. Manufacturer shall provide mechanical, electrical, network communication and environmental specifications.
30. Manufacturer shall provide installation guides.
31. Manufacturer shall provide system wiring diagrams.
32. Manufacturer shall provide applications engineering services.
33. Manufacturer shall provide the option of a factory-trained applications engineer for onsite supervision of startup and/or programming.
34. LED system shall comply with all relevant patents.

35. Manufacturer shall grant a license for use of relevant patents with the purchase of the patented LED lighting system.
36. Manufacturer shall have at least five years of experience designing, selling and supporting intelligent LED systems.
37. Manufacturer shall be able provide a reference listing of at least 75 installations using its intelligent LED-based systems.

2.5 LED Down lights:

1. Housing, LED driver, and LED module shall be supplied from the same manufacturer.

2.6 LED Troffers:

1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
2. Housing, LED driver, and LED module shall be products of the same manufacturer.

2.7 Housing

Made of die cast or extruded aluminum, Integrated heat sink, Two exterior color options:

- (a) raw unpainted aluminum
- (b) light gray or silver color.

Housing can be easily opened and closed without a tool.

2.8 LED light fixture

- A. Exit light fixtures shall meet applicable requirements of NFPA .
- B. Housing and door shall be die-cast aluminum.
- C. For general purpose exit light fixtures, door frame shall be hinged, with latch. For vandal-resistant exit light fixtures, door frame shall be secured with tamper-resistant screws.
- D. Finish shall be satin or fine-grain brushed aluminum.

- E. There shall be no radioactive material used in the fixtures.
- F. Fixtures:
 - 1. Inscription panels shall be cast or stamped aluminum a minimum of 2.25 mm (0.090 inch) thick, stenciled with 150 mm (6 inch) high letters, baked with green color stable plastic or fiberglass. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on green color stable plastic or fiberglass.
 - 2. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
 - 3. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.
- G. Voltage: Multi-voltage (220 – 380V).

PART 3 EXECUTION

3.1 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.

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

PART 1 - GENERAL

- 1.01** All metallic equipment enclosures, steel conduit system, cable trays, trunkings, lighting fixtures, earthing pins of sockets, all non-current carrying metal parts of the electrical systems and any other equipment or system components required by the concerned local authorities and I.E.E. Regulations shall be earthed in an approved manner.
- 1.02** All earth connections shall terminate finally at the main low tension switch board earth bus and extended from there to earth electrodes as specified hereinafter.
- 1.03** The earthing system of the building shall be an independent system connected to the earth bus on the main low tension switch board. The neutral shall not be used for earthing and shall be connected to the earth only at the main low tension switch board.
- 1.04** The conduit system shall be considered as continuous for earthing purposes only if the conduit is rigid heavy gauge steel with threaded connections and lock nuts at all boxes and all connections of the conduit system shall be checked for good electrical continuity. Where flexible connections are made to equipment, earthing jumpers shall be provided.
- 1.05** In all other cases, a separate earth conductor in addition to the circuit wiring shall be included. The earth conductor shall be installed in the same conduit with the phase and neutral conductors and shall be sized in accordance with the concerned local authorities Regulations.
- 1.06** The B.O.Q. shows the main items required for the earthing system. The contractor should make provision in his offer for any unspecified material(s) that are required for the completion of the earthing system.

1.07 SYSTEM FUNCTION

The contractor shall plan and provide a system that will meet the requirements of BS 7430 and achieve the following.

- Limit the potential of any part of the installation to a pre determined value with respect to general mass of earth.
- Permit the flow of current in the event of a fault to earth so that the protective equip. has time to operate and thus isolate the faulty circuit.

- Ensure that, if a fault occurs, non current carrying metal work associated with the equipment does not attain a dangerous potential with respect to the general mass of earth.

1.08 SUBMITTALS

- A. Submit test reports of electrical resistance to earth.
- B. Indicate layout ground ring(s), showing system grounding electrode connections and routing of grounding electrode conductor.

PART 2 - PRODUCTS

2.01 The earth wires shall be covered with PVC and distinguished by Green colour or yellow/green colour of cross sections 6 sq.mm,16 sq.mm, 25 sq.mm or 50 sq.mm as required

2.02 All earthing conductors, tapes shall be high conductivity copper to BS 1432 having a minimum cross section of 25x3 mm.

2.03 EARTH ELECTRODES

Earth Electrode, comprising of 3 sections, each section to be 1200mm long and 16mm diameter. The electrode rod shall be made of high strength steel with copper for non-rusting. The copper shall be molten welded, the steel core for eliminating electrolytic action. One end of the rod shall be pointed without application of heat and driving head shall be provided at the other end. The sectional rods shall be coupled with strong bronze couplers. The coupler shall be threaded to fit the rod section. The rod shall be driven into the earth by means of a power hammer, clamps shall be provided for connecting external copper strips to the electrode, the clamps shall be of adequate size to take 25 x 3mm. strips.

2.04 ACCESSORIES

All accessories associated with the Earth System shall be of high conductivity copper and factory made. The chief ones are:

- A. Tape Clip
- B. D.C. Clip
- C. Test Clamps
- D. Various types of brackets.

PART 3 - EXECUTION

- 3.01** All electrical equipment in mechanical rooms within the scope of this document shall be earthed with earth tape fixed to walls. The earth tape shall be neatly and firmly secured to the walls maintaining 12mm. clearance therefrom and sized as shown on the Drawings.
- 3.02** The earth tape shall be connected to the low tension switch board earth bus.
- 3.03** All distribution boards, switch fuses and isolators shall be provided with an earth bus or earth terminal and these shall be connected to the earth bus in the main switch board by earth conductors included with the feeders.
- 3.04** On cable trays and in electrical riser shafts an earthing copper tape of 25 x 3mm shall be provided for earthing all distribution boards, isolators and equipment.
- 3.05** Connection between earth bars and equipment frames and stranded copper cables shall be made with appropriate compression lugs, bolts, nuts and lock washers. Contact surfaces shall be thoroughly cleaned and tinned.
- 3.06** Lugs, bolts, nuts, washers, screws, clamps, cleats and other items which come into direct contact with copper earth bars, tapes, cables, ...etc. shall be non-ferrous and manufactured from brass, bronze or other suitable conducting material which will not cause electrolytic corrosion. Connection between copper and galvanized structures shall additionally be tinned.
- 3.07** Earthed tapes shall be of continuous unbroken lengths. If jointing becomes absolutely necessary, then, after obtaining approval of the Engineer the tapes shall be joined by fusion welding 'Thermoweld' or similar process.
- 3.08** The earth bus in the main switch board shall be connected to the panel room earth bus. The panel room earth bus shall be connected to the earthing points.
- 3.09** The maximum earth resistance as measured at the earth bus shall be in accordance with the concerned local authorities Regulations. If this resistance cannot be obtained with two earth rods, additional earth rods or sectional earth rods shall be used to obtain the required resistance. Parallel connected earth rods shall be spaced at a distance of not less than the rod lengths and connected by 25 x 3mm. copper tape. If approved by the Engineer, earth plates or other earthing means may be used instead of the additional earth rods.

- 3.10** Measurement of earth resistance shall not be made within 48 hours after rainfall. The panel room earth bus shall be connected to the metallic water service of the building unless requested not to do so by the Ministry of Electricity.
- 3.11** The connection between earth conductors and earth rods shall be made by means of high strength corrosion resistant copper alloy connector clamps.
- 3.12** The tops of the electrodes shall be protected from any damage and shall be easily accessible. With a view of this, they shall be enclosed in pits equipped with covers. The presence of the electrode shall be indicated in English and Arabic.

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

SECTION 16760
DATA, VOICE AND VIDEO SYSTEM

PART 1 GENERAL

1.01 GENERAL

- A The data voice and video System shall comprise of Supply, installation, testing & documentation for a category 6 cabling for the mentioned project provisional.
- B Separate raceways shall be used for the data and voice and video 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, Voice and Video System as ONE package, having the following as a minimum:

- Computer cabling cabinets
- Data and Voice Outlet with RJ45 Sockets Category 6..
- UTP patch cords
- Category 6 cables
- Raceways, trunking, conduits etc
- All other components, accessories required to complete the first fix Data, voice and video 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 Jordan. & within the parameters of an ambient temperature varying from zero (0) to plus fifty five (45) 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 and voice 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 UTP CAT 6 (4 PAIRS) CABLES

Installation cables category 6, Enhanced, UTP

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 (°C) -20 to +60

Installation (°C) 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 (Ω /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 UTP CAT 6 PATCH CORDS (1M & 3M)

Cat.6 patch cords are used for connecting the network equipment to patch panels and telecommunications outlets. They are suitable for transmission frequencies of up to 250 MHz.

2.1.3 FEATURES OF CAT.6

- Fulfill the requirements of category 6 , Class E (250MHz) according to the present standard proposals of the ISO/IEC 11801 2nd edition.
- Comply with category 6 specifications of the IEC 60603-7-4 IEC 60603-7-5. components standard with the Cat.6

Patch Cords Connection Modules

- Each individual patch cord is tested and marked with a quality stamp
- Can also be used as cat.5e (backwards compatible)
- Color coding for service identification.
- New strain relief are provided with wide function
- Strain relief gem. TIA-568-B.1-1
- Labeling possible on the strain relief or on the color coding
- Lengths from 0.5 to 20 m available
- Impedance of 100ohm
- PVC, LSOH and LSFROH versions
- Security system
- Environment system

CAT.6 Patch Cords Data Sheet Materials

Plug housing contacts plating shielding
 UL 94-V0
 Polycarbonate
 Selective gold plate
 Tin-plated brass

Electrical Characteristics

Current Rating Voltage rating dielectric with standing voltage insulation resistance
 1.5 A (maximum) @ 25°C

150 VAC (maximum) 1000 VAC, 1 min. (60Hz) 500 MO (minimum)

Mechanical Characteristics Environmental Characteristics

Plug tolerances and Dimensions operating temperature

Compliant IEC 60603-7 10°C to 60°C

2.1.4 UTP RJ45 CONNECTION MODULES (FOR DATA/VOICE/VIDEO)

The Cat. 6 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. Both the shielded and unshielded version allow a tool-free and time-saving connection of the

Installation cables. Their blue color serves to distinguish them from the Cat.5e connection modules.

- Comply with the cat.6 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)

2.1.5 DUAL FACE PLATES:

The freenet 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. 6

Modules on the same outlet, ensuring an easy switch to a higher category - another freenet plus!

2.1.6 19" RJ45 PATCH PANELS. UTP CAT. 6

Patch panels are used for terminating horizontal Data/Voice or backbone installation cables and for serving as in interface to the various network equipment. In horizontal cabling, the RJ45 ports of the patch panel are connected in a star topology by four pair installation cables to the telecommunications outlets. In this way, network equipment such as host computers, concentrators, PABXs and so forth can be easily connected to the desired telecommunications outlets by means of patch/line cables. Patch panels and connection modules comply with the standards of ISO/IEC 11801, EN 50173 and EIA/TIA 568A.

For larger patch panels the use of Global Systems is recommended. The 19" 3D Global patch panels can be mounted with fifteen 4x1 port connection module holders or blind elements. This permits the building of patch panels with up to 60 RJ45/SC-RJ ports. With the aid of the adapter units various special solutions can be implemented.

The ingenious forced lock and unlock system guarantees that the elements are securely held in the 3D Rack.

Features

- Modular design of the patch panels with up to 60 shielded or unshielded RJ45 ports or 60 SC-RJ ports.
- Installation and service friendly thanks to the "Snap & Go" fastening system.
- Complete earthing system integrated in the shielded patch panel.
- Ready for the keying system "Data Safe Lock".
- Exchangeable labeling strips.
- Integrated cable tie shelf.

Technical Data

- Overall dimensions; 19", 3U, and 84HP.
- Patch panel profiles: aluminum neutrally anodized.
- Patch panels side walls: polyamide, fiber glass reinforced.
- Color side walls: median gray/NCS 2502-B.
- Connection module holder: polycarbonate, fiber glass reinforced.
- Color connection module holder: light gray/NCS 1005-R80B.
- Slider: polycarbonate.
- Color slider; median gray/NCS 2502-B.
- Halogenated: no (according to DIN/VDE 0472/815).
- Fire classification side walls: UL94HB.
- Fire classification connection module holder: UL94V-0.
- Certifications: UL type approved in File no. E174388;
CSA certified in File no. LR110513.

Wireless Access Point:

The wireless access point should provide the following technical specifications:

- provides 54 Mbps of capacity and backward compatibility with older 802.11b clients
- Wireless access point should be equipped with integrated antenna and provide omni directional coverage
- Wireless access point should permit Variable transmit power settings tuned to different requirements
- Wireless access point should support hardware-assisted Advanced Encryption Standard (AES) encryption
- Wireless access point should support IEEE 802.11i-compliant; Wi-Fi Protected Access 2 (WPA2) and WPA certified
- The wireless access point should support 802.3af-compliant power sources
- Should support the following security protocols:
 - 802.11i, WPA2, and WPA
 - 802.1X
 - AES, TKIP
 - FIPS 140-2 Pre-Validation List
- The wireless access point should be able to operate in standalone mode and as a lightweight access point with wireless controller

2.1.7 SECURITY SYSTEM

Plug Guard

- Tool-free mounting onto outlets and patch panels.
 - Available in 3 colors.
- Connection can only be released with the matching key.**
- UL and CSA certified.
 - Halogen-free-material.
 - Patented.
 - Patented Plug Guard -the connection is secure and can
 - Only be released with the matching key.

Color Coding:

Face plate. Patch cords and patch panels should be color coded with the same color for each connection.

2.1.8 CABINETS

Communication Cabinets it can hold the: -

Major LAN components, like backbone switches, main routers,.. etc. Data/Voice and video 19" patch panels

The Data/Voice and video connection points will be covered and connected to the patch panels in this cabinet.

Cabinet free standing communication cabinet.

- NOT locally made.
- 19" Rack Standard
- 42 U heights for main, 600mm-width X 600mm-depth.
- Glass front door with lock.
- Metal back door with lock.
- Removable side panels.
- Fan tray with two cooling fans with sensors.

2.1.9 TRUNKS

Plastic trunks with different sizes should contain all the exposed cabling installation (if any).

2.02 FO TECHNICAL SPECS:

Cables should be connect the floors distributions

FO TECHNICAL SPECS:

2.2.1 The system FO cabling system comprises a large selection of fiber optic installation cables.

Fiber optic cables system can be used for data, voice and video transmission, as well as for all presently known and pained protocols.

Depending on the application and installation, FO Simplex/Duplex cables, FO mini and full-breakout and various types of bundled loose tube cable are - available. Campus cabling can be achieved with outdoor or indoor/outdoor cable (loose tube cable). For building backbone applications the indoor/ outdoor cable (Mini-Breakout) is advantageous as it permits fast and easy field-termination of ST, SC or MT-RJ connectors. Moreover. SC-RJ, LSH and other connectors can be spliced on as pigtails. Single-fiber drop cables are for example used for horizontal cabling where they provide a simple "Fiber to the desk" or "Fiber to the office" solution with connectors that can be field-terminated, This is where the new "Easy-Strip+" semi-tight buffer are used.

Features

Appropriate cable designs are available for all the various cabling environments and customer requirements.

Various fiber types are available.

All fiber types are Gigabit Ethernet compatible.

1 GBit, 10 GBit Ethernet OM1, OM2, OM3, OS1.

Pure indoor cables or combined indoor and outdoor cables are made from flame-retardant LSZH (low smoke zero halogen or ULSZH).

Technical Data of the Fibers

In ace. with standard ISO/IEC 11801	OM1	
Fiber	[μm]	G62.5/12
Core □	[μm]	62.5 ± 3
Cladding	[μm]	125 ± 2
Primary Coating	[μm]	250 ± 15
Effective refraction index	(850 nm)	1.482
	(1300nm)	1.477
	(1310nm)	-
	(1550nm)	-
Attenuation (cable)	[dB/km] (850 nm)	3.50
	[dB/km] (1300nm)	1.00
	[dB/km] (1310 nm)	-
	[dB/km] (1310 nm)	-
Bandwidth	[MHz x km] (850 nm)	≥ 200
	[MHz x km] (1300 nm)	≥ 600
Chromatic dispersion	[ps/(km x nm)] (1310 nm)	-

The fiber-to-the-desk solution for direct connector mounting. The cable is easy to install and provides a cost-effective solution in confined spaces.

The mini-breakout cable comes standard with an ULSZH sheath.

Features

- 900- μm «Easy-Strip+» semi-tight buffer.
- Indoor / outdoor cable.
- Differently colored semi-tight buffer elements for safe distinction.
- Fiber-to-the-desk.
- Lightweight, easily installed.
- Various diameters available.
- Flame-retardant halogen-free ULSZH jacket (Universal Low Smoke Zero halogen).

Technical Data of the Mini-Break-Out Cable

Number of fibers	2	4	2	4	6	8
Cable (mm)	3.4	3.4	4.7	4.7	6.0	6.0
Tensile strength(N)	220	220	500	500	1000	1000
Crush resistance (N)	1000	1000	2000	2000	2000	2000
During Installation(mm)	50	50	70	70	90	90
Temperature range (°C)	-20 /+70	-20 /+70	-20 /+70	-20 /+70	-20 /+70	-20 /+70

2.2.2 SC-RJ CONNECTORS

Worldwide the smallest SC duplex connector in conformance with the International Standards ISO/IEC 11801 and TIA/EIA 568.

- High transmission security Gigabit/10 Gigabit Ethernet
- SC security standard up to the workstations
- Snap-in or one-channel module
- Compatible with RJ45 assembly dimensions and could be installed in RJ 45 standard outlet and in the copper patch panel.
- Top quality standard

The SC connector is ideal for LAN and campus cabling applications as well as workstation cabling. Recommended by the standards it is the most widely used fiber optic connector in LAN applications.

Main features of the SC-RJ connector

- Push-pull system
- 2.5 mm ceramic ferrule for highest quality
- Torsion-proof (Rx/TX)
- Low insertion loss

- Field-termination

Main Features of the SC-RJ adapter:

- Fits the RJ45 cut-out
- Snap-in or one channel module
- Zirconium ceramic alignment sleeve for MM and SM
- SC simplex compatible

2.2.3 FO PATCHES PANELS: (12 X TYPE SC-RJ) PORTS

19" Patch panels in sliding technique are designed for the requirements of simple and efficient FO cabling systems. In particular, sliding technique allows swift and easy frontal access to the connectors without having to dismount the patch panel.

Features

- Adjustable slide-in unit (0-55mm)
- Integrated patching guide.
- Optional : splice tray to mount
- Cable entry from the rear or from the side
- Small mounting depth of 230mm
- Contains three radius guards
- Guarantee minimum bending radius of 40mm

2.03 VOICE BACKBONE

The separate worlds of voice and data transmission are increasingly growing together. Modern private automated branch exchanges (PABX) for example, offer ISDN capability not only on the exchange side but internally which means that computers with ISDN boards can be operated as PABX extensions. This means that in the future in-house telephone networks will develop into multi-functional systems in which voice, data and video singles can be transmitted. However, in-house telephone networks are not suitable for transferring large quantities of data at high bit rates. For this reason in-house telephone and data networks will continue to exist side-by-side in the coming years.

In the telephone cabling of a building multi-conductor branch cables are run in a star-shaped configuration from the distributor (MD) to the distribution boxes (DB). There the DBs are installed together with the data cable patch panels in the floor distributor (FD) cabinets.

The floor distributors as well as the patch panels are the interface to horizontal voice and data cabling within the floors. At this transition point there are many possibilities

for combining the two separate cabling systems into a common, application-independent cabling system.

In the following pages we introduce two different possibilities how you can easily, and economically, implement the voice integration between your secondary telephone and tertiary communication.

Scope of Solution

The JT cable will be terminated in 3rd party PABX into and Connection modules in the MDF, these VS-Compact modules will be jumbered into another VS-Compact connection modules in the same MDF with the multi pair cable.

UTP CAT 6 (4pairs) will be installed from the user face plate to a normal data patch panel (4 pairs connector termination).

VOICE INTEGRATION

2.3.1 MAIN DISTRIBUTION FRAME (MDF)

Today's PABX have 8or 16 ports per board, the VS compact 8 and 16 pair connection modules allow to count in the same way.

That means one board corresponds to one module. This way you will have a neat overview on the distributor.

The VS Compact distribution system features a high degree of modularity and flexibility. The result: existing distribution racks- including those containing active components- can be expanded at low cost.

The integrated wire cutting function in all modules means that only simple tools are needed. The result: a significant lowering of maintenance costs.

2.3.2 VS- COMPACT CONNECTING MODULES.

To be installed in the MDF (item 3.1)

For wall mounting.

For 5,8,10,16 and 20 pair modules and 90°c or 45°c mounting.

Features

- Simple and fast assembly
- Designed for modular equipment and extension
- Neat cable management

Common features of material

- High material quality and excellent corrosion protection through the use of stainless steel.
- Deburred, smooth mounting profiles to reduce the risk of injury.
- Punched opening for spacers, umpiring straps and other aids.

2.3.3 VS- MULTIPAIR INSTALLATION CABLES, CAT6.

To be installed from the MDF (in the main computer Room to the Voice Patch Panel).

Multipair, FTP shielded, Category 6 cables.

Suitable for voice, video and data transmission at frequencies of up to 16 MHz.

Dimensions: pair x 4 x 0.5mm (AWG24)

PVC or LSOH jacket.

Flame-retardant and halogen-free according to IEC 60332-1

Solid copper, 24 AWG, twisted-pair backbone multipair cable, 25,50 or 100 pairs cable shall have the Electrical characteristic shall exceed Cat3 requirements PVC or LSOH jacket.

2.3.4 VOICE INTEGRATION PATCH PANEL

The voice panel for flexible and efficient telephone cabling is a compact, clear interface for your telephone wires. Due to 19" technique you can integrate it and optimize it into a generic cabling system. The Voice panel provides up to 100 pairs connectivity for digital and analogue telephony.

Features

- 19" 1U Voice Panel with modular design and up to 50 RJ45/u ports.
- Category 3 performance in conformance with EIA/TIA 568A, EN 50173 and ISO/IEC 11801.
- Tool-free “ Easy Lock” IDC connection techniques for installation cables with conductor diameters 0.25mm- 0.65mm (AWG 30-22).
- Strands = AWG 26/7- 24/7. Admissible Insulation –0.7-1-6.
- Labeling holders with exchangeable labeling strips.
- Duct for optimum cable management.
- Ready for earth connection
- Suitable for multipair cable.

Technical Data Connection Module 10 x RJ45/u (R35116)

Temperature range in operation - 10 °C to + 55 °C

NEXT > 34 dB/16 MHz

Attenuation < 0.1 dB/16 MHz

Dielectric strength > 1000 V Ac off

Insulating resistance > 500 MOHM

2.3.5 UTP CAT 6 (4 PAIRS) CABLES

Installation Cables Category 6 Enhanced, and UTP (to be installed from the user face plate to a normal Data Patch Panel).

The pair-shielded 100ohm installation cables are suitable for voice, video 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

Features

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 [°C]-20 to + 60

Installation [°C] 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 ± 150

DC-loop resistance [Ω /km] 150

Resistance unbalanced, max.[%] 2

Optical braid coverage [%] 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 unbalances, max. [pF/m] 1000

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 at least 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 16960 BUILDING SURVEILLANCE SYSTEM (CCTV)

Part 1 Product:

Fixed dome:

Certifications, Standards and Ratings

1. EMC
 - a. CE-EMC
 - b. RCMJ
 - c. IC
 - d. KC
2. Safety
 - a. UL
 - b. CB
 - c. CE-LVD
 - d. BIS
3. Sustainability
 - a. RoHS:
 - b. WEEE:
 - c. Reach: Regulation (EC)
4. Mechanical Standards
 - a. IK10
 - b. IP67

Submittals

Product Data

1. Installation and operating manuals for any and all equipment required for a VMS (Video Management System)
2. Manufacturer's warranty documentation minimum five years

Qualifications

Requirements

1. This product shall be manufactured by an enterprise whose quality systems are in direct compliance with ISO-9001 protocols.
2. All system components shall be carefully tested and proven in actual use. Comprehensive repair and spare parts shall be given, for which the manufacturer shall provide warranty.

All installations, integration, testing, programming, system commission, and related work shall be done by installers who are trained, authorized, and certified by the manufacturer.

IR Fixed Dome Network Camera with the following characteristics:

1. The camera shall provide 6 MP high resolution (3200 × 1800) in 1/2.4" progressive scan CMOS format with a frame rate of up to 20 fps
2. The camera shall have an angle adjustment of pan: 0° to 355°, tilt: 0° to 75° rotate: 0° to 355°.
3. the camera shall have a lens focal length of 2.8 mm (fixed lens) with an aperture of F1.6.
4. The camera shall have IR range of up to 40 m

Imaging

1. Minimum illumination
Color 0.003 Lux at F1.6, 0 Lux with Light, Black and White 0 Lux with IR
2. Illuminator
 - a. IR
 - b. Effective distance up to 40 meters
 - c. The IR LEDs on camera should support Smart IR function to automatically adjust power to avoid image overexposure.
3. Lens and sensor
 - a. 6 MP camera
1/2.4" Progressive Scan CMOS sensor and fixed lenses of 2.8
 - b. the field of view shall be
Horizontal FOV 105°, vertical FOV 55°, diagonal FOV 127°;
 - c. The aperture shall be F 1.6

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4. Image processing
 - a. The Shutter Speed of the camera shall be 1/3 s to 1/100,000 s.
 - b. The camera shall support wide dynamic range up to 120 dB.
 - c. When true WDR is on , the 6 MP camera shall have the ability to provide maximum resolution of 3200 × 1800 @ 20 fps,
 - d. The camera shall have image day/night switch via ICR. Five switch modes are available, which are staying at night, staying at day, auto switch, scheduled switch, triggering by alarm input and triggering by video. For auto switch, sensitivity level is selectable range
 - e. Image parameters shall be adjustable on brightness, contrast, saturation, and sharpness.
 - f. The camera shall support the rotation function when you use the camera in a narrow view scene. If the aspect ratio is 16:9, the camera can rotate 90° to get a 9:16 image.
 - g. The camera shall have Backlight Compensation (BLC) with configurable BLC area.
 - h. The camera shall have Highlight Compensation (HLC).
 - i. The camera shall provide digital noise reduction with selectable noise reduction level from 0 to 100 in normal mode and configurable spatial and temporal DNR level in expert mode.
 - j. The camera shall provide defog function to enhance image in foggy weather.
 - k. The camera should support all the events at same time, namely, line crossing, intrusion, region entrance, region exiting, unattended baggage detection, object removal detection, scene change detection, and defocus detection.
 - l. Image mirror shall be supported.
 - m. The camera shall feature selectable 50/60 Hz flicker control/reduction.
 - n. The camera shall offer programmable polygon privacy mask to block privacy areas on live image, 4 masks available and mask color and mosaic configurable.

Events and Smart Features

1. Camera shall support events:
 - a. Motion Detection – user-defined areas and configurable sensitivity levels in normal mode and additional image settings switch in expert mode.
 - b. Video Tampering – Video changed in the configured area in image.
 - c. Exception – HDD full, HDD error, network disconnected, IP address conflicted, and illegal login.
 - d. The camera should support all the events at same time, namely, line crossing, intrusion, region entrance, region exiting, unattended baggage detection, object removal detection, scene change detection, and defocus detection.
2. The camera shall have the ability to count the number of people crossing a predefined line in the predefined count area, and display and export the real-time data of people entering and exiting. Up to three count areas are supported.
3. The camera shall have the ability to count people number in 8 configured ten-sided regions and detect people number changes and crowded situation, push alarms of people number exception or waiting time exception occurs.
4. The camera shall have the ability to capture and select the best human face.
5. The camera shall provide arming schedule settings for events and linkage actions settings as response to detected actions.
6. The camera shall provide linkage actions such as sending email, notifying surveillance center, uploading to FTP/memory card/NAS, triggering recording, triggering alarm output, triggering capture, audible warning. Some of which may not be supported by certain events.
 - a. Send Email – Alarm information is sent to a configured email recipient.
 - b. Upload to FTP/Memory Card/NAS – Captured picture is sent to a configured FTP server, mounted local memory card, or configured NAS.
 - c. Notify Surveillance Center – Alarm information is sent to the surveillance center (PC or mobile client software)
 - d. Alarm Output – Send alarm signal to external devices.

Trigger Channel Recording – Trigger camera to record a video

Video

- The camera shall offer 4 defined video streams.
- Compression
 - a. Main stream: H.265, H.265+, H.264, H.264+
 - b. Sub-stream: H.265, H.264, MJPEG
 - c. Third stream: H.265, H.264
 - d. Fourth stream: H.265, H.264, MJPEG
- Streams
 - a. Main stream:
 - 50 Hz:
 - 20 fps (3200 × 1800)
 - 25 fps (2688 × 1520, 1920 × 1080, 1280 × 720)
 - 60 Hz:
 - 20 fps (3200 × 1800)
 - 30 fps (2688 × 1520, 1920 × 1080, 1280 × 720)
 - b. Sub-stream:
 - 50 Hz: 25 fps (1280 × 720, 640 × 480, 640 × 360)

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- 60 Hz: 30 fps (1280 × 720, 640 × 480, 640 × 360)
- c. Third stream:
 - 50 Hz: 10 fps (1920 × 1080, 1280 × 720, 640 × 480, 640 × 360)
 - 60 Hz: 10 fps (1920 × 1080, 1280 × 720, 640 × 480, 640 × 360)
- d. Fourth stream:
 - 50 Hz: 10 fps (1280 × 720, 640 × 480, 640 × 360)
 - 60 Hz: 10 fps (1280 × 720, 640 × 480, 640 × 360)
- H.264 and H.264+
 - a. Baseline profile, main profile and high profile (H.264)
 - b. H.264+ is available for main stream
- H.265 and H.265+
 - a. Main profile (H.265)
 - b. H.265+ is available for main stream
- The video stream bit range shall be in the range 32 Kbps to 16 Mbps
- The camera shall provide constant and variable bit rate control.
- Scalable Video Coding (SVC) shall be supported when H.264 or H.265 is used. With SVC on, the camera should be able to extract frames from the original video when the network bandwidth is insufficient.
- The camera shall support audio in/out.
- The sampling rate of the camera shall be 8 kHz/16 kHz/32 kHz/44.1 kHz/48 kHz.
- The camera shall have environment noise filter to improve audio quality.
- ROI
 - a. The camera shall provide Region of Interest (ROI) encoding with 5 configurable fixed areas for each stream.
 - b. The ROI areas are encoded with better image quality than the background.
- The camera shall have the ability to support 6 simultaneous live view.

Network

1. Following network protocol shall be supported:
TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, NTP, UPnP, SMTP, IGMP, 802.1X, QoS, IPv4, IPv6, UDP, Bonjour, SSL/TLS, PPPoE, SFTP, ARP, SNMP, WebSocket, WebSockets, SRTP
2. Security
 - a. User permission control to assign different permissions to different user levels. Three user levels are available: admin, operator and user.
 - b. IP address filtering to block or allow certain IP addresses.
 - c. Password protected access not dependent on a server.
 - d. Secure activation for the first time access.
 - e. Video stream watermark.
 - f. RTSP and web authentication: digest and basic/digest
 - g. Illegal login lock to limit failed login attempts.
 - h. End-device access control via EAP-TLS1.2. Only permitted device can access to the video security network to avoid the risky access of unknown devices.
 - i. The video streams can be encrypted via RTP over HTTPS, AES128 and AES256 are supported.
 - j. Signaling is encrypted via HTTP in transmission link, AES128 and AES256 are supported.
3. System compatibility
 - a. Open Network Video Interface profile G, profile S and profile T
 - b. ISAPI
 - c. SDK
4. Network storage
 - a. NAS (NFS, SMB/CIFS)
 - b. Auto Network Replenishment (ANR) for recording

System

1. The camera support web browser and client software access:
 - k. Plug-in required web browser: IE 10, IE 11,
 - l. Plug-in free web browser: Chrome 57.0+, Firefox 52.0+, Edge 89+,
 - m. Local service: Chrome 57.0+, Firefox 52.0+, Edge 89+
2. The camera shall support up to 32 users with 3 user levels (admin, operator and user).
3. The camera shall provide 33 language options for web browser access:
English, Russian, Estonian, Bulgarian, Hungarian, Greek, German, Italian, Czech, Slovak, French, Polish, Dutch, Portuguese, Spanish, Romanian, Danish, Swedish, Norwegian, Finnish, Croatian, Slovenian, Serbian, Turkish, Korean, Traditional Chinese, Thai, Vietnamese, Japanese, Latvian, Lithuanian, Portuguese (Brazil), Ukrainian
4. The camera should support new firmware notification via the client software and online upgrade.
5. The camera should support file system backup for the firmware to ensure the stable device running in case of the abrupt power shut down or network interruption during upgrading.
6. The camera shall support heartbeat function to allow the connected device or software to acquire camera status.
7. The camera shall provide reset button on camera body and in client software to restore device the parameters.
8. The camera shall offer embedded open platform function to install and run up to 4 extra applications.

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Physical

1. The camera shall support lens angle adjustment: pan: 0° to 355°, tilt: 0° to 75° rotate: 0° to 355°.
2. The camera shall have a built-in memory card slot, available for microSD/SDHC/SDXC memory card, capacity up to 512 GB.
3. ROM: 8GB; RAM: 1 GB
4. Interfaces:
 - n. 1 RJ45 10M/100M self-adaptive Ethernet port
 - o. Audio:
 - 1 input (line in), two-core terminal block, max. input amplitude: 3.3 Vpp, input impedance: 4.7 K Ω , interface type: non-equilibrium,
 - 1 output (line out), two-core terminal block, max. output amplitude: 3.3 Vpp, output impedance: 100 Ω , interface type: non-equilibrium
 - Alarm:
 - 1-ch alarm in and 1-ch alarm out (max. 12 VDC/VCA, 30 mA)
 - p. Power output: 12 VDC, max. 100 mA
5. Power supply, power consumption and current:
 - a. Power over Ethernet (PoE):
 - IEEE 802.3at, Class 3, max. 9.5 W
 - b. DC input with reverse polarity protection:
 - 12 VDC \pm 25%, 0.66 A, max. 8 W, \varnothing 5.5 mm coaxial power plug, reverse polarity protection
6. Material
 - a. Body: Aluminum alloy
7. Environment
 - a. Starting and Operating Temperature: -30° C to 60° C (-22° F to 140° F)
 - b. Humidity: 95% or less (non-condensing)

Varifocal Bullet Network Camera

1.3 Certifications, Standards and Ratings**Reference Standards**

5. EMC
 - e. CE-EMC
 - f. RCM (For 4 MP and 6 MP models)
 - g. IC
 - h. KC
6. Safety
 - e. UL
 - f. CB
 - g. CE-LVD
 - h. BIS
7. Sustainability
 - d. RoHS
 - e. WEEE
8. Reach
9. Mechanical Standards
 - c. IK10
 - d. IP67

1.4 Submittals**Product Data**

3. Installation and operating manuals for any and all equipment required for a VMS (Video Management System)
4. Manufacturer's warranty documentation minimum five years

1.5 Qualifications**Requirements**

3. This product shall be manufactured by an enterprise whose quality systems are in direct compliance with ISO-9001 protocols.
4. All system components shall be carefully tested and proven in actual use. Comprehensive repair and spare parts shall be given, for which the manufacturer shall provide warranty.
5. All installations, integration, testing, programming, system commission, and related work shall be done by installers who are trained, authorized, and certified by the manufacturer.

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IR Varifocal Bullet Network Camera with the following significant characteristics:

5. The camera shall 6 MP high resolution (3200 × 1800) in 1/2.4" progressive scan CMOS format with a frame rate of up to 20 fps.
6. The camera shall have an angle adjustment of pan: 0° to 355°, tilt: 0° to 90° rotate: 0° to 360°.
7. the camera shall have a lens focal length of 2.7 to 13.5 mm (motorized lens) with an aperture of F1.6.
8. The camera shall have a focus that is auto, semi-auto, and manual.
9. The camera shall have an IR range of up to 60 m (197 ft)

Imaging

5. Minimum illumination
 - a. 6 MP camera:
 - Color 0.003 Lux at F1.6, 0 Lux with Light, Black and White 0 Lux with IR
 - Illuminator
 - d. IR
 - e. Effective distance up to 60 meters in 2.7 to 13.5 mm focal range
 - f. The IR LEDs on camera should support Smart IR function to automatically adjust power to avoid image overexposure.
 - Lens and sensor
 - d. 6 MP camera:
 - 1/2.4" Progressive Scan CMOS sensor and motorized lenses of 2.7 mm to 13.5mm
 - e. the field of view shall be
 - : Horizontal FOV 106° to 35.6°, vertical FOV 55.9° to 20°, diagonal FOV 127.4° to 40.8°;
 - f. the aperture shall be F 1.6
 - g. The camera shall support iris type: auto-iris.
 - h. The camera shall support 3 focus control modes, auto, semi-auto, and manual.
 - Image processing
 - o. The Shutter Speed of the camera shall be 1/3 s to 1/100,000 s.
 - p. The camera shall support wide dynamic range up to 120 dB.
 - q. When true WDR is on, the camera shall have the ability to provide maximum resolution of 3200 × 1800 @ 20 fps.
 - r. The camera shall have image day/night switch via ICR. Five switch modes are available, which are staying at night, staying at day, auto switch, scheduled switch, triggering by alarm input and triggering by video. For auto switch, sensitivity level is selectable range
 - s. Image parameters shall be adjustable on brightness, contrast, saturation, and sharpness.
 - t. The camera shall support the rotation function when you use the camera in a narrow view scene. If the aspect ratio is 16:9, the camera can rotate 90° to get a 9:16 image.
 - u. The camera shall have Backlight Compensation (BLC) with configurable BLC area.
 - v. The camera shall have Highlight Compensation (HLC).
 - w. The camera shall provide digital noise reduction with selectable noise reduction level from 0 to 100 in normal mode and configurable spatial and temporal DNR level in expert mode.
 - x. The camera shall provide defog function to enhance image in foggy weather.
 - y. The camera shall provide selectable white balance modes: MWB, AWB1, AWB2, Locked WB, Fluorescent Lamp, Incandescent Lamp, Warm Light Lamp, and Natural Light.
 - z. Image mirror shall be supported.
 - aa. The camera shall feature selectable 50/60 Hz flicker control/reduction.
 - bb. The camera shall offer programmable polygon privacy mask to block privacy areas on live image, 4 masks available and mask color and mosaic configurable.

Events and Smart Features

- Camera shall support events:
 - e. Audio Exception – monitors sudden audio increase/decrease and audio loss. This requires connection and configuration of optional external microphone.
 - f. Motion Detection – user-defined areas and configurable sensitivity levels in normal mode and additional image settings switch in expert mode.
 - g. Video Tampering – Video changed in the configured area in image.
 - h. Exception – HDD full, HDD error, network disconnected, IP address conflicted, and illegal login.
 - i. The camera should support all the events at same time, namely, line crossing, intrusion, region entrance, region exiting, unattended baggage detection, object removal detection, scene change detection, audio exception detection, and defocus detection.
 - The camera shall have the ability to count the number of people crossing a predefined line in the predefined count area, and display and export the real-time data of people entering and exiting. Up to three count areas are supported.
 - The camera shall have the ability to count people number in 8 configured ten-sided regions and detect people number changes and crowded situation, push alarms of people number exception or waiting time exception occurs.
 - The camera shall have the ability to capture and select the best human face.

- The camera shall provide arming schedule settings for events and linkage actions settings as response to detected actions.
- The camera shall provide linkage actions such as sending email, notifying surveillance center, uploading to FTP/memory card/NAS, triggering channel recording, triggering alarm output, triggering capture, and audible warning. Some of which may not be supported by certain events.
- e. Send Email – Alarm information is sent to a configured email recipient.
- f. Upload to FTP/Memory Card/NAS – Captured picture is sent to a configured FTP server, mounted local memory card, or configured NAS.
- g. Notify Surveillance Center – Alarm information is sent to the surveillance center (PC or mobile client software)
- h. Alarm Output – Send alarm signal to external devices.
- i. Trigger Recording – Trigger camera to record a video.

Video & Audio

- The camera shall offer 4 defined video streams.
- Compression
 - e. Main stream: H.265, H.265+, H.264, H.264+
 - f. Sub-stream: H.265, H.264, MJPEG
 - g. Third stream: H.265, H.264
 - h. Fourth stream: H.265, H.264, MJPEG
 - Streams
 - e. Main stream:
 - 50 Hz:
 - 20 fps (3200 × 1800)
 - 25 fps (2688 × 1520, 1920 × 1080, 1280 × 720)
 - 60 Hz:
 - 20 fps (3200 × 1800)
 - 30 fps (2688 × 1520, 1920 × 1080, 1280 × 720)
 - f. Sub-stream:
 - 50 Hz: 25 fps (1280 × 720, 640 × 480, 640 × 360)
 - 60 Hz: 30 fps (1280 × 720, 640 × 480, 640 × 360)
 - g. Third stream:
 - 50 Hz: 10 fps (1920 × 1080, 1280 × 720, 640 × 480, 640 × 360)
 - 60 Hz: 10 fps (1920 × 1080, 1280 × 720, 640 × 480, 640 × 360)
 - h. Fourth stream:
 - 50 Hz: 10 fps (1280 × 720, 640 × 480, 640 × 360)
 - 60 Hz: 10 fps (1280 × 720, 640 × 480, 640 × 360)
 - H.264 and H.264+
 - c. Baseline profile, main profile and high profile (H.264)
 - d. H.264+ is available for main stream
 - H.265 and H.265+
 - a. Main profile (H.265)
 - b. H.265+ is available for main stream
 - The camera shall provide constant and variable bit rate control.
 - Scalable Video Coding (SVC) shall be supported when H.264 or H.265 is used. With SVC on, the camera should be able to extract frames from the original video when the network bandwidth is insufficient.
 - The camera shall support audio in/out.
 - The camera shall provide audio function with compression standards of G.711 (64 kbps), G.722.1 (16 kbps), G.726 (16 kbps), MP2L2 (32 to 192 kbps), PCM, MP3 (8 to 320 Kbps), and AAC-LC (16 to 64 Kbps).
 - The sampling rate of the camera shall be 8 kHz/16 kHz/32 kHz/44.1 kHz/48 kHz.
 - The camera shall have environment noise filter to improve audio quality.
 - ROI
 - c. The camera shall provide Region of Interest (ROI) encoding with 5 configurable fixed areas for each stream.
 - d. The ROI areas are encoded with better image quality than the background.
 - The camera shall have the ability to support 6 simultaneous live view.

Network

- Following network protocol shall be supported: TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, NTP, UPnP, SMTP, IGMP, 802.1X, QoS, IPv4, IPv6, UDP, Bonjour, SSL/TLS, PPPoE, SFTP, ARP, SNMP, WebSocket, WebSockets, SRTP
 - Security
 - q. User permission control to assign different permissions to different user levels. Three user levels are available: admin, operator and user.
 - r. IP address filtering to block or allow certain IP addresses.
 - s. Password protected access not dependent on a server.
 - t. Secure activation for the first time access.
 - u. Video stream watermark.
 - v. RTSP and web authentication: digest and basic/digest

- w. Illegal login lock to limit failed login attempts.
- x. End-device access control via EAP-TLS1.2. Only permitted device can access to the video security network to avoid the risky access of unknown devices.
- y. The video streams can be encrypted via RTP over HTTPS, AES128 and AES256 are supported.
- z. Signaling is encrypted via HTTP in transmission link, AES128 and AES256 are supported.
 - System compatibility
- d. Open Network Video Interface profile G, profile S and profile T
- e. ISAPI
- f. SDK
 - Network storage
- c. NAS (NFS, SMB/CIFS)
- d. Auto Network Replenishment (ANR) for recording

System

- The camera support web browser and client software access:
- aa. Plug-in required web browser: IE 10, IE 11,
- bb. Plug-in free web browser: Chrome 57.0+, Firefox 52.0+, Edge 89+,
- cc. Local service: Chrome 57.0+, Firefox 52.0+, Edge 89+
- dd. Client software
 - The camera shall support up to 32 users with 3 user levels (admin, operator and user).
 - The camera shall provide 33 language options for web browser access:
 - English, Russian, Estonian, Bulgarian, Hungarian, Greek, German, Italian,
 - Czech, Slovak, French, Polish, Dutch, Portuguese, Spanish, Romanian, Danish, Swedish,
 - Norwegian, Finnish, Croatian, Slovenian, Serbian, Turkish, Korean, Traditional Chinese,
 - Thai, Vietnamese, Japanese, Latvian, Lithuanian, Portuguese (Brazil), Ukrainian
 - The camera should support new firmware notification via the client software and online upgrade.
 - The camera should support file system backup for the firmware to ensure the stable device running in case of the abrupt power shut down or network interruption during upgrading.
 - The camera shall support heartbeat function to allow the connected device or software to acquire camera status.
 - The camera shall provide reset button on camera body and in client software to restore device the parameters.
 - The camera shall offer embedded open platform function to install and run up to 4 extra applications.

Physical

- The camera shall support lens angle adjustment: pan: 0° to 355°, tilt: 0° to 90° rotate: 0° to 360°.
- The camera shall have a built-in memory card slot, available for microSD/SDHC/SDXC memory card, capacity up to 512 GB.

ROM: 8GB; RAM: 1 GB

Interfaces:

- ee. 1 RJ45 10M/100M self-adaptive Ethernet port
- ff. Audio:
 - 1 input (line in), two-core terminal block, max. input amplitude: 3.3 Vpp, input impedance: 4.7 K Ω , interface type: non-equilibrium,
 - 1 output (line out), two-core terminal block, max. output amplitude: 3.3 Vpp, output impedance: 100 Ω , interface type: non-equilibrium
- gg. Alarm:
 - 1-ch alarm in and 1-ch alarm out (max. 24 VDC/VCA, 1 A)
- hh. Connector panel: It can avoid cutting a big cable routing hole on installation surface and reduce working hour spent on tidying up cables.

Power supply, power consumption and current:

- c. Power over Ethernet (PoE): IEEE 802.3at, Class 4, max. 15 W
- d. DC input with reverse polarity protection: 12 VDC \pm 25%, 1.08 A, max. 13 W, two-core terminal block

Material

- b. Body: Aluminum alloy

Environment

- c. Starting and Operating Temperature: -30° C to 60° C (-22° F to 140° F)
- d. Humidity: 95% or less (non-condensing)

1.3 Certifications, Standards and Ratings

A. Reference Standards

10. EMC
 - a. FCC
 - b. CE-EMC
 - c. RCM
 - d. IC-EMC
 - e. KC

11. Safety
 - a. UL
 - b. CB
 - c. CE-LVD
 - d. BIS
12. Environment
 - a. RoHS
 - b. WEEE
 - c. Reach

1.4 Submittals

A. Product Data

5. Manufacturer's hard (physical) or soft (Electronic) datasheets
6. Installation and operating manuals for any and all equipment required for a VMS (Video Management System).
7. Manufacturer's warranty documentation minimum five years

1.5 Qualifications

A. Requirements

6. This product shall be manufactured by an enterprise whose quality systems are in direct compliance with ISO- 9001 protocols.
7. All system components shall be carefully tested and proven in actual use. Comprehensive repair and spare parts shall be given, for which the manufacturer shall provide warranty.
8. All installations, integration, testing, programming, system commission, and related work shall be done by installers who are trained, authorized, and certified by the manufacturer.

1.7 Licensing and Support Agreements

A. Recorder

1. Requires no licensing fees per channel or device, for basic software.
2. Requires no Software Support Agreements with the manufacturer.

B. Free DDNS Service

Part 2 Product:

2.2 Description

10. The NVR should support up to 256 channel IP video input. .
11. The NVR should support recording resolution includes 12 MP/8 MP/6 MP/5 MP/4 MP/3 MP/1080p/UXGA/720p/VGA/4CIF/DCIF /2CIF/CIF/QCIF.
12. The NVR shall be able to select from the following recording streams:
 - a. Main Stream
 - b. Sub Stream

The 256-ch NVR should support Incoming/outgoing bandwidth (RAID is enabled) not less than 768 Mbps/768 Mbps, and Incoming/outgoing bandwidth (RAID is disabled) not less than 768 Mbps/768 Mbps.
13. The NVR should have 2 HDMI and 1 VGA interfaces. The output resolution includes:
 HDMI1: 4K (4096 × 2160), 4K (3840 × 2160)/30Hz, 2K (2560 × 1440)/60Hz, 1080p (1920 × 1080)/60Hz, UXGA (1600 × 1200)/60Hz, SXGA (1280 × 1024)/60Hz, 720p (1280 × 720)/60Hz, XGA (1024 × 768)/60Hz
 VGA1/ HDMI2: 1080p (1920 × 1080)/60Hz, UXGA (1600 × 1200)/60Hz, SXGA (1280 × 1024)/60Hz, 720p (1280 × 720)/60Hz, XGA (1024 × 768)/60Hz
14. The NVR should support multiple 35 languages, which include English, Russian, Bulgarian, Hungarian, Greek, German, Italian, Czech, Slivinski, France, Polish, Dutch, Portuguese, Spanish, Romanian, Turkish, Japanese, Danish, Swedish, Norwegian, Finnish, Korean, Traditional Chinese, Thai, Estonian, Vietnamese, Croatian, Slovenian, Serbian, Latvian, Lithuanian, Uzbek, Kazak, Arabic, Indonesian.
15. The NVR shall support multi-user level management with password protection.
 Three-level user management; admin user is allowed to create many operating accounts and define their operating permission, which includes the limit to access any channel.
16. Secure Activation
 - a. The NVR shall not have a default admin password for enhanced cyber security. NVR shall require a secure password to be created and confirmed upon first connecting to the network.
 - b. A system algorithm shall check the user defined password for strength, based on the manufacturer's criteria.
 - c. System shall determine and display password security level as "weak", "medium", or "strong".
 - d. Password shall contain a minimum of two kinds of characters (lowercase letters, uppercase letters, numbers and special characters).
 - e. Only ASCII characters shall be allowed.

- f. Password length shall be eight characters minimum.
 - g. NVR cannot have a backdoor password. The device password shall be able to be recovered when login pattern and password is forgotten. The password resetting methods shall be defined and controlled by user, which should include user-defined security questions and email verification.
17. The NVR shall support ONVIF for third-party network camera support. Connectable to the third-party network cameras like ACTI, Arecont, AXIS, Bosch, Brickcom, Canon, PANASONIC, Pelco, SAMSUNG, SANYO, SONY, Vivotek , HUNTand ZAVIO, and cameras that adopt ONVIF protocol.
 18. The NVR shall be compatible with several free DDNS servers and support third-party network cameras.
 19. The NVR should support dual operation system.

2.3 Decoding, Recording and Playback

1. The NVR should support H.265/H.265+/H.264/H.264+/MPEG4 decoding format.
2. The NVR should support 12 MP/8 MP/7 MP/6 MP/5 MP/3 MP/1080p/UXGA/720p/VGA/4CIF/DCIF/2CIF/CIF/QCIF.
3. Audio decoding format: G.711ulaw, G.711alaw, G.722, G.726, AAC, MP2L2.
4. Video playback types shall include instant/event/tag/log/external file.
5. The NVR Shall offer 16-channel, 1080p independent playback and support picture capture and playback.
6. The NVR shall tag video clip, and offer search and playback by tag, as well as digital zoom on live view and playback.
7. The NVR shall be able to provider a snapshot icon for manual capture during live view and playback.
8. The NVR shall be able to playback the video footage at 8x without skipping and at rates up to 256x for improved video search.
9. The NVR should support holiday recording schedule configuration.
10. The NVR should support continuous and event video recording parameters.
11. The NVR should support multiple recording types: manual, continuous, alarm, motion, motion | alarm, motion & alarm VCA, and POS.
12. The NVR should support POS information overlay on image.
13. The NVR should support pre-record and post-record for alarm, motion detection for recording, and pre-record time for schedule and manual recording.
14. The NVR should support to search videos and captured pictures by events (alarm input/motion detection).
15. The NVR should support tag adding for record files, searching and playing back by tags.
16. The NVR should support to lock and unlock videos.
17. The NVR should support local redundant recording and capture.
18. The NVR playback operation should be easy and flexible.
19. The NVR should support searching and playing back record files by channel number, recording type, start time, end time, etc.
20. The NVR should support playback by main stream or sub stream.

21. The NVR should support smart search for the selected area in the video.
22. The NVR should support zooming in when playback.
23. The NVR should support reverse playback of multi-channel.
24. The NVR should support pause, play reverse, speed up, speed down, skip forward, and skip backward when playback, and locating by dragging the mouse.
25. The NVR should support thumbnails view and fast view during playback.
26. The NVR should support playback by transcoded stream.
27. The NVR should support manual capture, continuous capture of video images and playback of captured pictures.
28. The NVR should support to enable H.265+ to ensure high video quality with lowered bitrate.
29. The NVR shall be able to support a 1/2/4/6/8/9/16/32/64 split screen in live view on connected monitor, and support click and drag the live view window to automatically adjust displayed camera order.
30. The NVR should support capture settings by timing, motion and alarm type, maximum 8 time zones each day, each time zone maximum 1 hour.

2.4 Storage

1. The device shall be able to form an N+1 hot spare system to improve data reliability. The hot spare system shall consist of several working video recorders and one hot spare video recorder. When a working video recorder fail, the hot spare video recorder would switch into operation and take over the failed working video recorder. When the failed working device come back online, the hot spare device would restore videos back into the failed working device.
2. Up to 16/24 SATA hard disks and 1 eSATA disk can be connected.
3. Up to 10 TB storage capacity for each disk supported.
4. Supports 8 network disks (NAS/IP SAN disk).
5. Supports S.M.A.R.T. and bad sector detection.
6. HDD group management.
7. Supports HDD standby function.
8. HDD property: redundancy, read-only, read/write (R/W).
9. HDD quota management; different capacity can be assigned to different channel.
10. The NVR should support RAID 0, 1, 5, 6, 10.
11. The NVR should support hot-swappable RAID storage scheme. And 8 arrays can be configured.
12. Supports disk clone to the eSATA disk.

2.5 Network

1. Four self-adaptive 10/100/1000 Mbps network interfaces, and the multi-address and network fault tolerance working modes are configurable.
2. TCP/IP, DHCP, IPv4, IPv6, DNS, DDNS, NTP, RTSP, SADP, SMTP, SNMP, NFS, iSCSI, ISUP, UPnP™, HTTP, HTTPS are supported.
3. Auto/Manual port mapping by UPnP™.
4. Remote web browser access by HTTPS.

5. The ANR (Automatic Network Replenishment) function is supported, it enables the IP camera save the recording files in the local storage when the network is disconnected, and synchronizes the files to the NVR when the network is resumed.
6. Remote reverse playback via RTSP.
7. Supports accessing by the platform via ONVIF.
8. Remote search, playback, download, locking and unlocking of the record files, and support downloading files broken transfer resume.
9. Remote parameters setup; remote import/export of device parameters.
10. Remote viewing of the device status, system logs and alarm status.
11. Remote keyboard operation.
12. Remote HDD formatting and program upgrading.
13. Remote system restart and shutdown.
14. RS-232, RS-485 transparent channel transmission.
15. Alarm and exception information can be sent to the remote host.
16. Remotely start/stop recording.
17. Remotely start/stop alarm output.
18. Remote PTZ control.
19. Remote JPEG capture.
20. Virtual host function is provided to get access and manage the IP camera directly.
21. Two-way audio: 1-ch, RCA (2.0 Vp-p, 1 k Ω).

2.6 Alarm

1. Configurable arming time of alarm input/output.
2. Alarm for video loss, motion detection, tampering, abnormal signal, video input/output standard mismatch, illegal login, network disconnected, IP confliction, abnormal record/capture, HDD error, and HDD full, etc.
3. POS triggered alarm supported.
4. VCA detection alarm is supported.
5. VCA search for human search, vehicle search, people counting and heat mapping.
6. Connectable to the thermal network camera.
7. Supports the advanced search for fire/temperature/temperature difference detection triggered alarm and the recorded video files and pictures.
8. Alarm triggers full screen monitoring, PTZ linkage, audio alarm, notifying surveillance center, sending email and alarm output.
9. Automatic restore when system is abnormal.

2.9 Physical Design

- | | |
|-------------------------|---|
| 1. Operation Conditions | 0 °C to + 50 °C (32 °F to 122 °F) |
| 2. Humidity | 10 to 90 % |
| 3. Power Supply | 100 to 240 VAC |
| 4. Power Consumption | ≤ 140 W (without HDD disk) |
| 5. Dimensions | 442 × 494 × 146 mm (17.4 × 19.4 × 5.7 inch) |
| 6. Weight | ≤ 16 kg (35.3 lb) |
| 7. Chassis | 19-inch rack-mounted 3U chassis |

1. Operation Conditions 0 °C to + 50 °C (32 °F to 122 °F)
2. Humidity 10 to 90 %
3. Power Supply 100 to 240 VAC
4. Power Consumption ≤ 140 W (without HDD disk)

1. Operation Conditions 0 °C to + 50 °C (32 °F to 122 °F)
2. Humidity 10 to 90 %
3. Power Supply 100 to 240 VAC
4. Power Consumption ≤ 140 W (without HDD disk)
5. Dimensions 447 × 528 × 172mm (17.6 × 20.8 × 6.8 inch)
6. Weight ≤ 23 kg (50.7 lb)

Part 3 Execution

3.1 Examination

- A.** Inspect chosen area of installation prior to receiving devices and report any conditions that affect the installation process or any subsequent operation.
- B.** Please do not begin installation until all unacceptable conditions are rectified.

3.2 Preparation

- A.** Assess the compatibility of mounting screws for all equipment to be installed.
- B.** Make sure all video systems are tested properly and meet standard operational requirements.
- C.** Define, conclude, and report all issues with equipment to the manufacturers' customer service representatives.

3.5 Adjusting

- A.** Execute the necessary modifications to the Video Management System for proper operation in accordance with the instructions provided by the manufacturer.
- B.** Ensure the customers unique requirements are reflected in the camera settings.

3.6 Demonstration

- A.** Upon final inspection, validate the video solutions system and its device functions correctly.

END OF SECTION