

**DIVISION 16**

**ELECTRICAL**

**BUILDING WORK**

**DIVISION 16**

**ELECTRICAL**

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**SECTION 16010****ELECTRICAL GENERAL PROVISIONS****PART 1 - GENERAL****1.01 SUMMARY**

Provide labor, materials and equipment required for complete and functioning electrical systems as required by the contract documents.

- I. **New Work.** The work includes, but is not limited to, the following principal systems and equipment:
  - 1- 380/220 volt distribution.
  - 2- Switchgear.
  - 3- Panelboards.
  - 4- Packaged emergency generating system.
  - 5- Automatic transfer switches.
  - 6- Lighting fixtures, poles, lamps and ballasts.
  - 7- Fire alarm system.
  - 8- Public address system.
  - 9- Telephone system cables.
  - 10- Simultaneous systems.
  - 11- Projection
  - 12- Security System

**1.02 APPLICABLE PROVISIONS**

- I. Provisions Specified Elsewhere. Unless modified in this section, General and Supplementary General Conditions, applicable provisions of Division 1 - General and other provisions of contract documents apply to work of Division 16 - Electrical.
- II. Application. Provisions of this section apply to every section of Division 16 - Electrical, except where specifically modified.

### 1.03 RELATED WORK

- I. Site Work.
- II. Concrete.
- III. Doors and Windows.
- IV. Painting.
- V. Equipment.
- VI. Conveying Systems.
- VII. Mechanical.

### 1.04 REFERENCE CODES AND STANDARDS

Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

- I. Association of Edison Illuminating Companies (AEIC).
- II. American National Standards Institute (ANSI).
- III. Institute of Electrical and Electronics Engineers (IEEE).
- IV. Insulated Cable Engineers Association (ICEA).
- V. National Electrical Code (NEC).
- VI. British Code (BS)
- VII. National Electrical Manufacturers Association (NEMA).
- VIII. National Electrical Safety Code (NESC).
- IX. National Fire Protection Association (NFPA).
- X. Underwriters' Laboratories (UL).

### 1.05 REGULATIONS AND PERMITS

- I. **Regulations:** Work, materials and equipment must comply with the latest rules and regulations of the following:
  - 1- National Electrical Code (NEC).
  - 2- National Electrical Safety Code (NESC).
  - 3- Occupational Safety and Health Act (OSHA).
  - 4- Local, State and federal codes, ordinances and regulations in Jordan.

- II. **Discrepancies:** The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Engineer in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.
- III. **Permits:** Obtain certificates of inspection and other permits required as a part of the work.

## 1.06 CONTRACT DRAWINGS

- I. **Intent:** The intent of the drawings is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. Electrical drawings are generally diagrammatic and show approximate location and extent of work. Install the work complete, including minor details necessary to perform the function indicated. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the Engineer.
- II. **Discrepancies:** Review pertinent drawings and adjust the work to conditions shown. Where discrepancies occur between drawings, specifications, and actual field conditions, immediately notify the Engineer for his interpretation.
- III. **Outlet and Equipment Locations:** Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical and plumbing drawings. Review with the Engineer any proposed changes in outlet or equipment location. Relocation of outlets before installation, of up to 2 meters from the position indicated, may be directed without additional cost. Remove and relocate outlets placed in an unsuitable location, when so requested by the Engineer.

## 1.07 CONTRACTOR QUALIFICATIONS

An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system. The Contractor will be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 1 year.

## PART 2 - PRODUCTS

### 2.01 PRODUCT REQUIREMENTS

- I. **Condition:** Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.
- II. **NEC and UL:** Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products and issued labels, products used must be listed and labeled by UL.
- III. **Space Limitations:** Equipment selected must conform to the building features and must be coordinated with them. Do not provide equipment which will not suit arrangement and space limitations.
- IV. **Factory Finish:** Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.

## PART 3 - EXECUTION

### 3.01 PROTECTION OF EQUIPMENT

- I. **Moisture:** During construction, protect switchgear, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually.
- II. **Clean:** Keep products clean by elevating above ground or floor and by using suitable coverings.
- III. **Damage:** Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
- IV. **Finish:** Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore any finishes that become stained or damaged.

### 3.02 INSTALLATION

- I. **Cooperation with Other Trades:** Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a

part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.

- II. **Workmanship:** Work must be performed by workmen skilled in their trade. The installation must be complete.
- III. **Concrete Equipment Pads:** Install 90 mm-thick concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 10 cm beyond equipment. Trowel pads smooth and chamfer edges to a 30 mm bevel. Secure equipment to pads as recommended by the manufacturer.
- IV. **Setting of Equipment:** Equipment must be leveled and set plumb. Sheet metal enclosures mounted against a wall must be separated from the wall not less than 20 mm by means of corrosion-resistant spacers or by 10 cm of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment. In sufficient time to be coordinated with work under other divisions, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
- V. **Sealing of Equipment:** Seal openings into equipment to prevent entrance of animals, birds and insects.
- VI. **Motors:**
  - 1- Electrical work includes the electrical connection of all motors, except those which are wired as a part of equipment.
- VII. **Concealed Work:** Conceal all electrical work in walls, floors, chases, under floors, underground and above ceilings except:
  - 1- Where shown or specified to be exposed. Exposed is understood to mean open to view.
  - 2- Where exposure is necessary to the proper function.
  - 3- Where size of materials and equipment preclude concealment.
- VIII. **Application:** Unless otherwise indicated, power will be utilized as follows:
  - 1- 380 volts, three phase: motors 3/4 horsepower and larger.
  - 2- 220 volts, single phase: motors 1/2 horsepower and smaller.
  - 3- 220 volts, single phase: incandescent, fluorescent and high-intensity-discharge lighting.
  - 4- 220 volts, single phase: fluorescent and high-intensity-discharge lighting.
  - 5- 220 volts, single phase: convenience outlets.
  - 6- 220 volts, single phase: special power and equipment.

7- 380 volts, three phase: special power and equipment.

- IX. **Substation transformers:** Use substation transformers to change the service to the required utilization voltage.

### 3.03 EQUIPMENT AND DEVICE MARKING

- I. **Designations:** Identify all equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the contract documents.
- II. **Nameplates:** Externally mark all electrical equipment with nameplates identifying each and the equipment served. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 30mm high by 75 mm long with 5 mm high engraved white letters. Supply blank nameplates for spare units and spaces.
- III. **Nameplate Fasteners:** Fasten nameplates to the front of equipment only by means of stainless steel self-taping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.
- IV. **Nameplate Information:** In general, the following information is to be provided for the types of electrical equipment as listed.
  - 1- Switchboards and Motor Control Centers. On the mains identify the piece of equipment, the source and voltage characteristics (i.e., 380/220V, 3PH 4W). For each branch circuit protective device, identify the load served.
  - 2- Individual Starters, Contactors, Disconnect Switches, Transfer Switches and similar equipment. Identify the device designation, source and load served.
  - 3- Panelboards. Identify the source, panelboard designation and voltage characteristics.
- V. **Panelboards:** Prepare a neatly typed circuit directory behind clear heat-resistant plastic in a metal frame attached to the inside of the door for each panelboard. Identify circuits by equipment served and by room numbers where room numbers exist. Indicate spares and spaces with light, erasable pencil marking. Adhesive mounted directory pocket is not acceptable.
- VI. **Pull, Junction and Outlet Boxes:** With 15 mm high lettering, identify conduits connected to pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags which indicate circuit designation.



- VII. **Equipment and Raceways Over 600 Volts:** Provide "WARNING - HIGH VOLTAGE - KEEP OUT" signs on all equipment. With 50 mm high lettering, mark all exposed raceways containing conductors operating in excess of 600 volts every 30 meters with the words "WARNING - HIGH VOLTAGE."
- VIII. **Power Receptacles:** Use nameplate or engrave device plate to identify power receptacles where the nominal voltage between any pair of contacts is greater than 220 volts with circuit number, voltage and phases. If nameplates are used, attach to wall directly above device plate.
- IX. **Wall Switches:** Where the equipment served is not in sight of the wall switch, provide an engraved switch plate or attach a nameplate to the wall directly above the switch.

### 3.04 TESTING

- I. **Test Conditions:** Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation. Perform specified tests in the presence of the Engineer. Furnish all instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the drawings and specifications. Special tests on certain items are specified hereinafter. Where specified that the testing be performed by an independent testing company, an Engineer approved NETA certified testing company shall be used.
- II. **Test Dates:** Schedule final acceptance tests sufficiently in advance of the contract date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the contract.
- III. **Retests:** Conduct retests as directed by the Engineer of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant delay as a result of such necessary retests does not relieve the Contractor of his responsibility under this contract.

**END OF SECTION**

**SECTION 16020**

**ELECTRICAL SERVICE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section pertains to making arrangements for electrical services.

**1.02 REFERENCE STANDARDS**

- A. Comply with all service installation standards of the serving utility.

**PART 2 - ELECTRICAL SERVICE REQUIREMENTS**

**2.01 SOURCE**

- A. Electrical service will be provided from JEPSCO system. The source characteristics are 380/220 volts, 3 phase, 4 wire, 50 hertz. Service to the project will be run via substation transformers located in substation room.

**2.02 COORDINATION**

- A. The location of the service entrance must be coordinated with the JEPSCO. Provide materials and equipment required to connect the project service to the utility system.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Install the utility services as required by JEPSCO and the contract documents. Demonstrate that the electrical system is operational.

**END OF SECTION**

**SECTION 16110****RACEWAYS****PART 1 - GENERAL****1.01 SUMMARY**

This section specifies the furnishing and installation of electrical raceway systems.

**1.02 REFERENCE STANDARDS**

- A. ANSI/ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated.
- B. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit.
- C. ANSI/UL 1 - Flexible Metal Conduit.
- D. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
- E. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
- F. ANSI/UL 884 - Underfloor Raceways and Fittings.
- G. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- H. UL 6 - Rigid Metal Conduit.

**1.03 SUBMITTALS**

None required.

**PART 2 - PRODUCTS****2.01 CONDUIT AND FITTINGS**

- A. **Rigid Metal Conduit.**
  - 1- Conduit: Rigid hot-dipped galvanized steel (RGS) conduit with zinc-coated threads and an outer coating of zinc chromate.
  - 2- Fittings: Threaded steel or malleable iron, either cadmium plated or hot-dipped galvanized.
- B. **PVC-Coated Rigid Metal Conduit.**
  - 1- Conduit: Same as rigid metal conduit plus a factory-applied, 40-mil-thick covering of polyvinyl chloride (PVC) bonded to the metal.

- 2- Fittings: Same as rigid metal conduit fittings plus a factory-applied, 40-mil-thick covering of PVC bonded to the metal.
- C. **Rigid Nonmetallic Conduit.**
- 1- Conduit: Schedule 40 polyvinyl chloride (PVC).
  - 2- Fittings: Solvent weld socket type.
- D. **Flexible Metal Conduit.**
- 1- Conduit: Spiral-wound, square-locked, hot-dipped galvanized steel strip.
  - 2- Fittings: One-screw and two-screw for 12 inches and larger, double-clamp steel or malleable iron, either cadmium plated or hot-dipped galvanized.
- E. **Liquid-tight Flexible Steel Conduit.**
- 1- Conduit: Spiral wound, square locked, hot dipped galvanized steel strip plus a bonded outer jacket of PVC.
  - 2- Fittings: Compression type, malleable iron, with insulated throat, either cadmium plated or hot dipped galvanized.

## PART 3 - EXECUTION

### 3.01 CONDUIT AND FITTINGS

- A. **Minimum Trade Size:** 3/4 inch, except that 3/8-inch flexible metal conduit may be used in lengths not exceeding 2 meters for tap conductors supplying lighting fixtures.
- B. **Types According to Use:** Use rigid steel conduit (RGS) throughout the project except as specified below.
- 1- Use PVC-coated RGS where exposed to rain, condensation, moisture, constant high humidity or corrosive atmospheres.
  - 2- Use PVC schedule 40 in interior walls or ceiling spaces and where exposed when installed more than 2.5 meters above finished floor in open work areas, mechanical rooms or electrical rooms. Conduit which enters or leaves the top of panelboards or enclosures may be PVC schedule 40, provided the top of the panelboards or enclosures are a minimum of 1.5 meters above finished floor and such panelboards and enclosures are located in mechanical or electrical rooms.
  - 3- RGS or rigid nonmetallic conduit 1 inch and smaller may be embedded in slabs if the slab thickness is a minimum of 12 cm thick.
  - 4- Use RGS or rigid nonmetallic conduit encased in concrete with minimum 6 cm thick walls, where installed below grade. All

horizontal to vertical transitions shall be made using RGS elbows and RGS conduit stub-ups.

- 5- Connect all electrical equipment subject to vibration or movement with liquid-tight flexible metal conduit 60 cm minimum length. Where the equipment is located in a duct or plenum used for environmental air, the length of conduit shall not exceed 1 meter and the conduit shall be flexible metal conduit.
  - 6- Transitions.
    - a. Continue the heavier, more protective type conduit application not less than 10 cm into the area where lighter, less protective type conduit is permitted.
    - b. For below-grade to above-grade outdoor locations, extend concrete encasement around conduit 10 cm above finished grade and slope top away from conduit with a 15-cm-per-foot slope.
    - c. For below-grade to above-grade locations using PVC to metal conduit, make the transition from PVC to metal conduit before turning up with RGS elbow.
- C. **Preparation:** Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins.
- D. **Installation Requirements.**
- 1- Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For PVC terminations, provide insulated throat bushings and on rigid metallic conduits, provide nonmetallic insulating bushings for conductor protection. Where conduits 4mm and larger terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.
  - 2- Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.
  - 3- Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed. Provide chrome-plated floor and ceil-

ing plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.

**E. Installation Methods.**

- 1- Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.
- 2- Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90 percent zinc paint. When dry, draw up tight.
- 3- Make bends with standard ells or conduit bent in accordance with the NEC. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of three 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.
- 4- Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.
- 5- Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits.
- 6- Provide a No.30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading "Pulling Line - Telephone," etc.
- 7- Suitably cap conduit during construction to avoid water, dirt and trash entrance.
- 8- Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.
- 9- With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.
- 10- Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be firestopped to maintain the fire resistance rating using approved methods.

**END OF SECTION**

**SECTION 16115****CABLE TRAYS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. This Section includes cable trays and accessories.
- B. Related Sections include the following:
  - 1. "Firestopping" for firestopping materials and installation requirements.
  - 2. "Basic Electrical Materials and Methods" for cable tray supports specified in other Sections.

**1.03 SUBMITTALS**

- A. Product Data: Include data indicating dimensions and finishes for each type of cable tray.
- B. Shop Drawings: Detail fabrication and installation of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
- C. Design Calculations: Verify loading capacities for supports.
- D. Coordination Drawings: Include floor plans and sections drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural and mechanical elements.
- E. Factory-certified test reports of specified products, complying with NEMA VE
- F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements specified in "Field Quality Control" Article.
- G. Maintenance Data: For cable trays to include in the maintenance manuals specified in other Divisions.

**1.04 QUALITY ASSURANCE**

- A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
- B. Listing and Labeling: Provide cable trays and accessories specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in NFPA70, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. Comply with NEMA VE 1, "Metal Cable Tray Systems," for materials, sizes, and configurations.
- D. Comply with NFPA 70.

**1.05 COORDINATION**

- A. Coordinate layout and installation of cable tray with other installations.
  - 1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by Engineer.

**PART 2 - PRODUCTS****2.01 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements.

**2.02 MATERIALS AND FINISHES**

- A. Cable Trays, Fittings, and Accessories: Steel, with epoxy-resin paint finish over paint manufacturer's recommended primer and corrosion-inhibiting treatment.
- B. Protect steel hardware against corrosion by galvanizing according to ASTM B 633 or cadmium plating according to ASTM B 766.
- C. Fabricate cable tray products with rounded edges and smooth surfaces.
- D. Sizes and Configurations: Refer to Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.



**2.03 CABLE TRAY ACCESSORIES**

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: None required.
- C. Barrier Strips: Same materials and finishes as cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

**2.04 SOURCE QUALITY CONTROL**

- A. Perform design and production tests according to NEMA VE1.

**PART 3 - EXECUTION****3.01 EXAMINATION**

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of cable trays. Do not proceed with installation until unsatisfactory conditions have been corrected.

**3.02 INSTALLATION**

- A. Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- B. Remove burrs and sharp edges from cable trays.
- C. Fasten cable tray supports securely to building structure as specified in Division 16 Section "Basic Electrical Materials and Methods," unless otherwise indicated.
  - 1. Locate and install supports according to NEMA VE1.
  - 2. Design supports, including fastenings to the structure, to carry the greater of the calculated load multiplied by a safety factor of 4 or the calculated load plus 90 kg (which ever is larger).
- D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independently of fittings. Do not carry weight of cable tray on equipment enclosure.
- E. Install expansion connectors where cable tray crosses a building expansion joint and in cable tray runs that exceed 27 m. Space connectors and set gaps according to NEMA VE .

- F. Make changes in direction and elevation using standard fittings.
- G. Make cable tray connections using standard fittings.
- H. Locate cable tray above piping, unless accessibility to cable tray is required or unless otherwise indicated.
- I. Seal penetrations through fire and smoke barriers according to "Firestopping" Section.
- J. Sleeves for Future Cables: Install capped sleeves for future cables through firestopping-sealed cable tray penetrations of fire and smoke barriers.
- K. Workspace: Install cable trays with sufficient space to permit access for installing cables.
- L. Use separate cable trays for different systems, such as power, low voltage system (i.e. fire alarm, public address, security, ... etc.).

### **3.03 CONNECTIONS**

- A. Ground cable trays according to manufacturer's instructions.
  - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### **3.04 FIELD QUALITY CONTROL**

- A. Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections.
- B. Anchorage: Test pullout resistance for toggle bolts and powder-driven threaded studs for each type and size of anchorage material.
  - 1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales, required for reliable testing.
  - 2. Obtain Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener.
- C. Replace malfunctioning units.

### **3.05 CLEANING**

- A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

### **3.06 PROTECTION**

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure cable tray is without damage or deterioration at the time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
  2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

### **3.07 CABLE TRAY SCHEDULE**

1. Type: Ladder.
2. Material and Finish: Steel with epoxy-resin paint finish.
3. Width: 60 cm.
4. Cross-Rung Spacing: 50 mm.
5. Inside Depth: 15 cm.
6. NEMA Load/Span Class: NEMA VE1.

**END OF SECTION**

**SECTION 16120****WIRING****PART 1 - GENERAL****1.01 WORK INCLUDED**

- I. Single core and multicore 600 volt wiring, 10mm<sup>2</sup> and smaller.
- II. Fixture Wiring
- III. Signaling Systems Wiring
- IV. Power Distribution wiring

**1.02 RELATED WORK**

- I. Equipment Identification Section
- II. Grounding and Bonding Section

**1.03 REFERENCE STANDARDS**

- I. BS 6094, 6207, 6360
- II. IEC 227, 287, 502, 540

**1.04 SUBMITTALS**

- I. Submit product data and manufacturers literature
- II. Submit blank commissioning test sheets
- III. Submit proposals for colour coding of insulation
- IV. Submit completed test sheets.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- I. Building Wiring: Concentric lay, uncoated copper with a normal maximum operating temperature of 85 degrees C, 600V, PVC insulation.
- II. Power and Control wiring: Concentric lay, uncoated copper with a normal maximum operating temperature of 70 degrees C. Insulation to be 600 V PVC with black PVC jacket. Provide white conductor insulation with indelible black numerals at 25mm intervals on control cables. Maximum conductor size to be 10 mm<sup>2</sup>.

- III. Flame Retardant Power and control Wiring: Multi Strand, concentric lay, coated copper with a normal maximum operating temperature of 90 degrees C and 600V flame retardant cross linked polyethylene insulation and overall cable jackets of chlorosulfonated polyethylene, all in accordance with Standards and Codes. Cable jacket to be applied over tape wrapped cable cores.
- IV. Flame Retardant Alarm and instrument Cable: Multi strand, concentric lay, coated copper with a normal maximum operating temperature of 90 degrees C and 600V flame retardant cross linked polyethylene insulation, cable assembly shield of combination aluminum/mylar tape and 7 strand 0.6 mm<sup>2</sup> minimum coated copper drain wire applied to achieve 100% cover over insulated conductors and chlorosulfonated polyethylene cable jacket. Twisted pair cables with 60 mm to 90 mm lay staggered. Each pair to be numbered.
- V. Fixture Wire: Standard round coated copper with a operating temperature of 200 degrees C with 600V silicone rubber insulated and braided glass jacket, all in accordance with Standards and Codes.
- VI. Telephone Cable: Single or multi-pair as required. Bare copper wire minimum 0.6mm diameter, 0.2mm thick PVC insulation, wires twisted to pairs with a cable core wrapping of insulating foil, additional 0.4mm diameter (up to 10 pairs) or 0.6mm diameter (above 10 pairs) ground wire, with aluminum foil wrapping, insulating foil wrapping and PVC cable assembly jacket. All telephone installations shall conform to Local Telecommunication Corporation Regulations and Approvals.
- VII. Fire alarm Signal Cable: shall be fire resistant multi-core cable to conform with civil defense regulations and manufacturer recommendations.
- VIII. Lighting/Power Cable: Multicore copper conductors 600V grade PVC insulation (minimum size 4 mm<sup>2</sup>).
- IX. Loudspeaker Cable: Single pair with solid copper conductor (1.25mm diameter) in flat configuration with polyethene insulation and PVC jacket. Conductors to have a maximum DC loop resistance at 20 degrees C of 28 ohms per kilometer and a nominal capacitance of 91 picofarads per meter.
- X. Microphone Cable: Single pair screened with stranded copper conductors (13/0.2mm) with PVC insulation lapped copper screen and PVC jacket. Conductors to have a maximum DC loop resistance of 45.7 ohms per kilometer and a nominal capacitance of 430 picofarads per meter.
- XI. Attendant Call Cable: Minimum 2.5 mm<sup>2</sup> cable as described in Part 2.01A above.
- XII. Slave Clock Cable: Minimum 1.5 mm<sup>2</sup> cable as described in Part 2.01A above.
- XIII. Control cable: Multicore 2.5 mm<sup>2</sup> cable as described in part 2.01A above.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- I. Ensure conductor lengths for parallel feeders are equal.
- II. Lace or clip conductor groups at switch gear panels, pull boxes, wire ways, etc.
- III. Provide grounding conductors and straps in accordance with other sections.
- IV. Wiring in conduit only to be installed after concrete, masonry and plastering work is complete and all conduits have been cleaned out and dried.
- V. Splice cables at accessible junction or outlet boxes only.
- VI. Colour code all wiring insulation as per other sections.
- VII. Terminate cables in accordance with the manufacturers recommendations.
- VIII. Colour codes : 220V System
  - Phases : Red, yellow, blue
  - Neutral : Black
  - Ground : Green/yellow in combination or green

### **3.02 TESTS**

- I. All power circuits shall be tested with the circuit complete except for connections to equipment.
- II. Test all wiring for continuity, polarity and insulation resistance after installation and before connection.

**END OF SECTION**