

SECTION 16100 MATERIALS & METHODS

PART 1 - GENERAL

1.01 NOTE

- A. The requirements of Section 16010 apply to work performed under this Section.
- B. The requirements of this Section of the Specifications apply to and form a part of the individual Electrical Sections of the Specifications.

1.02 SCOPE

- A. The Work under this Section of the Specification shall include the furnishing of labor, materials and equipment for the installation of a complete electrical system as shown on the Drawings and as specified herein.

PART 2 - MATERIALS

2.01 RACEWAYS

- A. Galvanized rigid threaded steel heavy-wall conduit (GRC) and couplings shall conform to Federal Specification WW-C-581, as amended, ANSI Standard C80.1 and shall bear the UL label.
- B. Galvanized Electrical Metallic Tubing (EMT) shall conform to Federal Specification WW-C-563, as amended, ANSI Standard C80.3 and shall bear the UL label.
- C. Intermediate metal conduit (IMC), galvanized, shall conform to Federal Specification WW-C-581, as amended, and shall bear the UL label.
- D. Rigid wall plastic conduit shall be polyvinyl chloride (PVC) heavy wall type 40 conforming to NEMA TC-2 and WC-1094 specification.
- E. Flexible steel conduit shall conform to Federal Specification, WW-C-566, as amended.
- F. Surface mounted raceways shall be Wiremold 500, 700 or 2000 series or equivalent with buff finish used as follows:
 - 1. #500: 4-#10 or 7-#12 wires maximum
 - 2. #700: 5-#10 or 8-#12 wires maximum
 - 3. #2000: 7-#10 or 7-#12 wires maximum (without receptacles)
 - 4. #3000: 43-#10 or 68-#12 wire maximum (with devices)
 - 5. #4000 with divider: 30-#10 or 48-#12 wire maximum (with devices)
 - 6. Other combinations of conductors shall be in accordance with the manufacturers published data and the National Electrical Code.
 - 7. Elbows, boxes, fittings, supports, etc., shall be by the raceway manufacturer. Finish

shall match that of the raceway.

- G. Provide Appleton liquid tight gasket assembly and "Sealtite" flexible conduit for flexible connections subject to weather, at liquid tight equipment, and as noted on the Drawings.
- H. Conduit used outdoors and in wet locations when cut and threaded in the field shall have a field-applied coat of rust-inhibitor applied over the threads.
- I. Minimum size shall be 3/4 inch.

2.02 CABLE

- A. Metal Clad cable shall be type 'MC' with insulated copper conductors and insulated ground wire. Insulation shall be type 'THHN' 90 degree C, 600 volts. Minimum wire size is #12 AWG for power circuits and #14 AWG for control wiring. Cable shall comply with Federal Specification JC-30B, per UL Standards 83, 1479, 1569 and 1581, and per NEC Articles 230, 300, 321, 334, 518, 520 and 530. The cable shall also bear the UL label.

2.03 CONDUCTORS

- A. Secondary wiring within the building shall be soft drawn copper 98 percent conductivity with 600 volt insulation, and shall be manufactured in accordance with the requirements of the National Electrical Code, the Board of Fire Underwriters, A.S.A., N.E.M.A. and I.C.E.A.
- B. Insulation shall be type THHN for feeders and subfeeders and THHN for branch circuits, for use as specified hereinafter, adequately color coded for identification.
- C. Wiring shall be as manufactured by Pirelli, General Electrical Company, Phelps Dodge, American Insulated Wire Corps or AFC.
- D. Pulling compound shall be UL approved, "Y-ER-Ease" or acceptable equal. Soap, grease or substances other than specified will not be allowed.

2.04 WIRE TROUGHS

- A. Wire trough shall be steel enclosed wireway meeting all UL requirements. Wire trough shall not be less than 16 gauge steel. Wire troughs shall be as manufactured by General Electric. Acceptable alternates: Square D, Siemens, Cutler-Hammer.

2.05 BOXES AND FITTINGS

- A. Boxes shall be all steel construction, spot or seam welded at the joints, and electro-galvanized or hot-dip galvanized after fabrication.
- B. Boxes shall be sufficiently rigid to withstand moderate twisting strains. Steel boxes of 100 cubic inches or less shall be #14 USS gauge, between 101 and 8500 cubic inches shall be #12 USS gauge, and larger boxes shall be #10 USS gauge. Barriers and reinforcing angles shall be supplied as required.

- C. Boxes shall be shaped as to permit surfacing materials to be cut in straight lines and fit closely around the box.
- D. All steel boxes except outlet boxes shall have a shop-applied finish of enamel, smooth, clear and continuous over the surfaces of the box and adhering firmly to the box.
- E. Junction and pullboxes shall have screw-attached covers. Each box shall have a turned in lip. It shall be welded at the joint to develop full strength. The lip shall be drilled and tapped for 1/8 inch of 3/16 inch round head screws, symmetrically placed. To provide adequate length of thread, nuts shall be attached by tackwelding on the inside of the lip or the lip shall be made double thickness. The cover shall be true and square. Plane surfaces shall be neither warped nor contain checks or pits. All welding burrs shall be ground smooth.
- F. Gang type boxes shall be of unit construction of the size required for the number of switches, or other devices and outlets shown. Gauged sectional switchboxes will not be permitted.
- G. Outlet boxes for all exposed conduit runs and for all outlets mounted on exterior of building shall be cast-rust-resistant metal type, with threaded hubs. Gasketed covers shall be provided where outlet is exposed to weather, dust or moisture, covers shall be provided with cap over each receptacle opening. The cap shall be permanently attached to the cover plate by two spring-hinged flaps.
- H. Boxes less than 50 cubic inches in size to accommodate wiring devices installed flush in exterior locations, and exposed on walls of unfinished interior spaces shall be cast boxes, equal to Crouse-Hinds type "FS" or "FD" Condulets. Equip boxes with matching covers.
- I. Pull boxes, junction boxes and wire troughs shall be provided where shown, specified or required by field conditions or the National Electrical Code to facilitate wiring installation except that boxes in finished areas shall be installed in approved locations only.
- J. Expansion joints for use with rigid galvanized steel heavy-wall conduit shall be O.Z./Gedney Electric Company AS Series type AX or EX on conduits crossing the joint. Expansion fittings for EMT shall be type TX.
- K. Cable supports shall be O-Z type "S".
- L. Insulating bushings O-Z type "A" shall be provided on rigid conduit terminations.
- M. Electrical Metallic Tubing couplings and box connectors installed in concrete or within masonry walls shall be concrete-tight, steel, compression ring type, employing O-Z "A" bushings. Elsewhere they may be die-cast zinc set screw type conduit fittings with insulated throat as manufactured by Thomas & Betts. EMT not terminating in a metal enclosure shall terminate with an O-Z type "SBT" bushing.
- N. Box connectors for flexible metal conduit shall be 2-screw clamp type or "Tite-Bite" with insulated throats as manufactured by Thomas & Betts or approved equal.
- O. Flush boxes for switches and receptacles shall be a minimum of 4 inches square, 1-1/2 inches deep with appropriate raised covers or plaster rings.

- P. Boxes in face block, brick or tile walls shall be located at the course line and fitted with square tile covers similar to Raco Series 782 or 792, or Steel City Series GW where walls are 6 inches or more in thickness.
- Q. Ceiling and wall recessed outlets for lighting fixtures shall be 4 inches octagonal, except where required by fixture design.
- R. Covers for pressed steel pull and junction boxes installed flush in walls of finished areas shall be blank stainless steel device plates. Covers for pressed steel pull and junction boxes in other locations shall be flat galvanized steel.

2.06 SAFETY SWITCHES

- A. Provide safety switches as shown on the Drawings and where required by the National Electrical Code. Switches shall be horsepower rated where applicable and shall be of the sizes required.
- B. Fusible safety switches, 240 volts or less, 30 amps thru 100 amps, 3 phase, 4 wire, with solid neutral and fused ungrounded conductors (or as required per drawings) shall be general-duty type. Switches shall be unfused or fused as indicated. Switches 200 amps thru 400, 240 volts or less, shall be heavy-duty type. Fusible safety switches 30 amps thru 400 amps, greater than 240 volts, shall be the heavy-duty type. Safety switches shall be side handle operated, and shall be NEMA 1 for general interior work and NEMA 3R for exterior work and damp locations. Switches shall be equipped with a cover interlock to prevent operation with cover open. Switches shall be designed to permit padlocking in the off or open position.
- C. Switches shall be visible blade, externally operated with current carrying parts silver or tin plated. Switches shall have provisions for not less than two external padlocks and capable of accepting copper or aluminum cables.
- D. Safety disconnect switches shall be as manufactured by General Electric. Acceptable Alternates: Square D, Siemens, Cutler-Hammer.
- E. Heavy duty switches employing current limiting fuses shall be rated to withstand let-through currents of 200,000 R.M.S. symmetrical amperes at 480 volts.
- F. Provide one (1) complete set of fuses in fuse spaces and leave on the job in a fuse cabinet one (1) complete replacement set.

2.07 FUSES

- A. Fuses shall be of the same manufacturer, shall be of the sizes indicated on the plans, and, where not indicated, shall be of the proper size for the equipment protected.
- B. Fuses classes, types and ratings have been chosen on the basis of Bussman fuses as listed herein. Other acceptable manufacturers are Little Fuse, Gould Shawmut, Cefco and F.P.E. Economy. Requests for change in manufacturer or fuse types from that specified below shall be accompanied by a complete coordination study indicating the suitability of the proposed changes.

- C. Fuses 601 amperes and greater for mains shall be UL Class L. Fuses shall be 100% rated. Interrupting rating shall be 200,000 R.M.S. symmetrical amperes. Fuses shall be designed in accordance with UL Standard for Class L fuses. Fuses shall be Bussman KTU.
- D. Fuses 600 amperes or less for mains shall be a fast-acting breaker(s), UL Class J or Class RK1, as required. The interrupting rating shall be 200,000 R.M.S. symmetrical amperes. Fuses shall be designed in accordance with UL Standard for Class J and Class RK1 fuses. Fuses shall be Bussman JKS (Class J) or KTN-R or KTS-R (Class RK1).
- E. Fuses rated 600 amperes or less for feeder circuits, motor circuits and general power circuits shall be a UL Class RK1 or J current limiting time-delay types. Interrupting rating shall be 200,000 R.M.S. symmetrical amperes. Fuses shall be Bussman LPN-RK or LPS-RK (Class RK1) or LPJ (Class J), as required.
- F. Fuses shall not be installed until installation is complete. Fuses shall be installed on the job site; they shall not be installed in equipment at the factory and shipped in place in the equipment.
- G. Where applicable, unless otherwise noted, provide the 'rejection' style fuses.

2.08 MOTOR STARTERS

- A. Motors shall be provided with starters under this Division or other Divisions of the Specifications as hereinafter designated in this Division of the Specifications.
- B. Starters for single phase motors shall be manual motor-starting switches unless otherwise indicated on the plans. Manual motor-starting switches shall have built-in thermal overload protection properly sized for the motor protected and shall be with pilot light. Motor-starting switches not in sight of motor controlled shall have handle guards which permit padlocking in the "Off" position. In finished areas where conduit is concealed, motor-starting switches shall be flush mounted. Single phase motor starters shall be by General Electric. Acceptable alternates: Square D "Class 2510", Siemens, Cutler-Hammer.
- C. Starters for 3-phase motors shall be magnetic, across-the-line type unless otherwise noted, single or 2-speed as indicated on the Drawings or as herein specified. Starters shall be provided with 3 overload heaters, one in each phase, properly sized for the motor protected. Starters shall have 120 volt coils and individual fused control transformers. Starters shown separately mounted, where both motor and starter are in sight of the branch circuit disconnecting device, shall be standard line starters. Line starter shall be by General Electric. Acceptable alternates: Square D "Class 8536", Siemens, Cutler-Hammer.
- D. Where starter is not in sight of the branch circuit disconnect device or of the motor served, provide a combination type starter with disconnect switch. Combination starter/disconnect shall be by General Electric. Acceptable alternates: Square D "Class 8538", Siemens, Cutler-Hammer.
- E. Where two or more starters are supplied from the same branch circuit, the starters shall incorporate adjustable instantaneous trip only motor circuit protectors set just above locked

rotor current of the motor (with current limiter). Motor circuit protectors shall be by General Electric. Acceptable alternates: Square D "Class 8539", Siemens, Cutler-Hammer.

- F. Starter shall have NEMA 1 enclosures except in exterior or damp locations where they shall have NEMA 4 enclosures.
- G. Starters shall be provided with motor running green pilot lights and key operated hand-off-automatic selector switches mounted in the cover. Starters shall be provided with minimum of one set of normally open and one set of normally closed auxiliary interlock contacts and additional sets as required by control sequences specified in other Sections of this Specification and indicated on mechanical control diagrams.
- H. Starters not separately mounted shall be installed in motor control centers or motor starting panelboards as hereinafter specified.
- I. Where motors are provided with integral thermal overload protection, horsepower rated motor switches shall be provided.

2.09 WIRING DEVICES

- A. Wiring devices shall be as manufactured by Pass & Seymour. Acceptable manufacturers: Hubbell, General Electric, Arrow-Hart, Leviton.
- B. Switches, 20A, 120/277V shall be catalog number 20AC series.
- C. Duplex receptacles, 20A, 125V shall be catalog number 5352-I.
- D. Special receptacles shall include but not be limited to the following:

<u>NEMA Designation</u>	<u>Pass & Seymour Catalog No.</u>
Duplex, NEMA 5 - 15R (IG)	IG 6200
Duplex, NEMA L5 - 15R (IG)	IG 4700
Single, NEMA 5 - 50R	3803
Single, NEMA L15 - 20R	L1520-R
Single, NEMA 10 - 20R	6810
Single, NEMA L14 - 20R	L1420-R
Single, NEMA L5 - 20R	L520R
Single, NEMA L16 - 20R	L1620R
Single, NEMA L14 - 30R	L1430R
Single, NEMA 6 - 15R	5671

- E. Wall plates for wiring devices shall be 302 stainless steel by Pass & Seymour. Covers for devices designated as weatherproof shall be Pass & Seymour 4500 series.

PART 3 - EXECUTION

3.01 EQUIPMENT CONNECTIONS

- A. Conduit, outlets, wiring and other necessary fittings or accessories for power connections for heating equipment, fans and special furnishings shall be installed under this Section. Motor and equipment of different ratings shall be furnished and circuit components shall be adjusted accordingly.
- B. Make final connections to electrical equipment specified under this Section and other Sections of these Specifications.
- C. Mechanical connections of electrical circuitry throughout shall be tightened as required.
- D. Prior to project close-out the Contractor shall have the major equipment electrical connection points surveyed/tested/documented throughout by providing infra-red thermometric scanning of all equipment connection points of the power distribution system. The Contractor shall obtain the services of an Independent Testing Agency qualified to survey all major mechanical equipment connection points. The Agency and Technicians shall be NETA Certified. Tests shall be conducted under load. The equipment and mechanical connection points shall include but not be limited to Panelboards (mains, main circuit breakers, branch breakers, etc.), transformers, disconnect switches, automatic transfer switches. Failed connection points shall be corrected and re-tested. Satisfactory test results shall be submitted in writing. Failure to do so may result in the delay of final payments. The testing and reports shall be included as part of the facility's construction costs. They shall not be excluded and be passed along to the Owner.

3.02 SUPPORTS

- A. Provide supports for equipment and materials under these Specifications. Supports shall be structural steel shapes (angles, channels, etc.) of Kindorf or Unistrut. Minimum rod size shall be 3/8 inch. Equipment shall not be supported from roof deck or siding.
- B. Provide two point supports for wall and ceiling mounted pressed steel boxes and for sheet steel boxes whose largest surface is less than 200 square inches in area, except that additional support shall be provided where the conduit system in conjunction with these supports does not provide a rigid installation. Provide minimum of four point supports for boxes whose largest surface exceeds 200 square inches in area.
- C. Boxes for connection and support of lighting fixtures weighing 50 pounds or more shall have 3/8 inch threaded steel rod studs passing through the center knockout in the back of the box securely anchored to the building structure.
- D. Conduit supports shall be in accordance with the following:
 - 1. Exposed conduits shall be run parallel to one another on the surface walls or ceilings and shall follow contours of surface to which they are attached and shall be supported at a maximum of 10 foot intervals, employing one-hole pipe clamps securely fastened

- to the surface to which the conduit is attached.
2. Suspended conduits shall be supported by hangers used only for conduit support. Hanger rods shall not pierce ducts. Conduits shall not be supported from ducts or roof deck or siding or pipes or hangers provided under other Divisions for the support of pipes, ducts, or suspended ceilings. Individual concealed conduits 1-1/4 inch and smaller shall be suspended from 1/4 inch steel rod with "Caddy" spring steel conduit fasteners or the equivalent, on a maximum of 10 foot centers. Individual exposed conduits 1-1/4 inch and smaller shall be supported from suitably sized rod, minimum 1/4 inch diameter, employing Kindorf 6H Series or equivalent hangers on a maximum of 10 foot centers. Individually supported exposed or concealed conduits 1-1/2 inch and larger shall be supported on a maximum of 10 foot centers by means of a 1/4 inch minimum size rod with two-piece hinged malleable iron "F & M" hangers with threaded sockets to receive the support rod.
 3. Where two or more suspended conduits are run together, they shall be suspended from the structure by means of "trapeze" hangers consisting of angle or channel iron employing "U" bolts to secure the conduits at supports, or Kindorf channels with two-piece conduit straps engaging the channels. Supports for "trapeze" shall be suitably sized bolt rods. No conduit shall pass through beams unless so indicated by the Engineer. Conduits shall be located a minimum of 3 inches from steam or hot water piping.
- E. Cable supports in conduit risers shall be provided as required by the National Electrical Code.

3.03 CONDUIT METHODS

- A. Conduit methods shall conform to the National Electrical Code requirements and these Specifications and shall produce a complete, safe, well-built electrical system.
- B. Unless otherwise noted, Rigid steel zinc-coated conduit shall be used under the following conditions:
 1. In concrete walls and masonry walls.
 2. Exposed in damp or wet locations.
 3. Where required by the National Electrical Code in hazardous areas, etc.
 4. Vertical runs, where the supports are at intervals greater than 7'-0".
- C. Unless otherwise noted, Flexible metal conduit shall be used under the following conditions:
 1. In short lengths for connection to motor terminal boxes, dry transformers, engine generators, etc. Where such equipment is exposed to weather or in damp or wet locations, "Sealtite" or "Liquidtite" flexible conduit shall be employed.
 2. In lengths as required by the National Electrical Code between outlet boxes and recessed lighting fixtures.
 3. Where flexible metal conduit and associated fittings are not UL approved, as a grounding means, the conduit shall contain a ground wire bonded to boxes.
- D. Unless otherwise noted, Electrical Metallic Tubing (EMT) with set screw fittings may be used above grade, indoors, exposed or concealed in drywall or above hung ceilings. EMT may be installed in concrete or within masonry when using steel, concrete-tight ring-type compression fittings with O-Z A bushing or equal.

- E. Conduit sizes shall be in accordance with the National Electrical Code except as follows:
 - 1. None smaller than 3/4 inch, except that 1/2 inch may be used for control and signal wiring and where noted on the Drawings or elsewhere in these Specifications.
 - 2. Where Drawings indicate conduits larger than the National Electrical Code requirements.
- F. PVC conduit shall be buried in earth below the first floor slab or outside in building vicinity. Minimum size shall be 1" diameter.
- G. On this project, conduits shall be installed concealed in walls, below floors and above ceilings throughout, except as follows:
 - 1. Where suspended ceilings are not provided and the restrictions below prohibit conduit installation in concrete slab.
 - 2. In vertical shafts, electrical closets, etc., mechanical and electrical equipment spaces where concealment is not practical.
 - 3. At surface-mounted panelboards in otherwise finished spaces, limited to vertical runs above and below panel.
 - 4. Where required for equipment connections.
 - 5. Where indicated on the Drawings.
- H. Conduit shall be installed to afford least interference with other trades.
- I. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces and cold section plenums of air conditioning units shall be suitably sealed by means of "Duxseal" or sealing fittings to prevent accumulation of condensation.
- J. Cap conduits immediately after installation to prevent entrance of debris and moisture.
- K. Bends in conduits for high voltage, telephone, television and similar cables shall be made with wide-sweep field bends. Radius of wide sweep bends shall be as required by the National Electrical Code for conduits containing cables with lead sheath. No manufactured elbows permitted.
- L. Conduits turning from a slab to enter a partition shall be totally concealed.
- M. Concealed conduit runs below slabs or below grade may be heavy wall polyvinyl chloride (PVC).
- N. Conduits in close proximity one to the other in concrete slabs (at panelboards, etc.) shall be located and wrapped with wire mesh to prevent cracking of slab, as directed and approved by the Structural Engineer.
- O. Conduit nipples connecting outlets in adjoining rooms shall be packed with Johns-Manville "Duxseal" after wires are in place to prevent transmission of noise between rooms unless nipples are 12 inches or more in length.
- P. Aluminum conduit shall not be permitted on this project.
- Q. Provide 1/8 inch polypropylene pull cord in empty conduit systems.

- R. Conduit fittings similar to Crouse-Hinds "Condulets" may be installed in exposed work to facilitate wiring installation and as indicated on the Drawings. They shall not be used for conduits that are to contain high voltage, telephone, television, or like wiring which cannot tolerate a sharp bend. They shall not be used where space permits the use of an adequately sized sheet steel pull box. Service entrance condulets may be used only on control wiring installations.
- S. Fire-proofing of penetrations of conduits through floors and fire rated walls is specified herein under "Fire Spread Prevention".
- T. Where conduits leave concrete slabs, PVC coated steel elbows shall be employed for corrosion protection.
- U. Where conduits penetrate the roof to equipment specified under Division 15, route the conduits through the curb provided under Division 15. Where conduits cannot be fed through mechanical curbs, provide separate curb and flashing for conduit(s).

3.04 BOXES AND FITTINGS

- A. Thru-wall boxes or boxes mounted back-to-back shall not be permitted, except where specifically indicated by notes on drawings.
- B. Boxes mounted flush in or exposed on walls shall be exactly plumb. Flush boxes shall not project beyond the finished wall surface nor shall wall surfaces project more than 1/8 inch beyond the lips of flush boxes. Major axis of receptacle outlets shall be vertical.
- C. Outlet boxes for surface mounted fixtures shall be set flush with the finished ceiling or wall. Flush or recessed fixtures shall be provided with separate junction boxes when required by the fixture terminal temperature requirements. Boxes installed in concealed locations shall be set flush with the finished surfaces. Boxes in plastered walls or ceiling shall be provided with plaster rings.
- D. Conduit junction boxes and pullboxes located outdoors shall be gasketed with screw covers mounting on outward turned flanges of boxes, provided with mounting lugs and conduit hubs.
- E. Gang boxes containing both low voltage or communications system wiring and branch circuit conductors or containing normal and emergency system wiring shall be equipped with internal barriers to separate the two systems, as required by the National Electrical Code.

3.05 WIRING

- A. No aluminum wire shall be used on the project unless requested by the Contractor in writing and approved for use by the Architect/Owner.
- B. Wire and cable shall be delivered to the job site in full coils or reels, each bearing a tag containing the Underwriter's approval stamp, name of manufacturer, trade name, code, type of wire, and month and year manufactured.
- C. Conductors shall be copper; sizes shall be AWG. Minimum size for power and lighting

circuits shall be #12. Minimum size for 120 volt control circuits shall be #14. Minimum insulation rating of conductors shall be 600 volts.

D. Wires No. 8 and larger shall be stranded. Minimum wire size shall be No. 12 unless otherwise noted. Conductors shall be continuous from outlet and no splices shall be made except within outlet or junction boxes.

E. Insulation shall be as follows, except as otherwise noted on the Drawings, or specified.

Lighting Branch Circuits:	Type THHN/THWN
Feeders, and sub-feeders:	Type THHN/THWN
Power Branch Circuits:	Type THHN/THWN
Controls:	90 degree machine tool wire
Connections to Fluorescent	Type THW 90 degree Fixtures
Connections to Incandescent	Type AF (#14 min) Fixtures (300 volts, insul.)

F. A color coding system shall be as follows throughout the building's network of feeders and circuits and used as a basis of balancing the load.

Systems	Color	Phase A	Phase B	Phase C
Neutral				
277/480V	Brown	Orange	Yellow	Gray
120/208V	Black	Red	Blue	White

Color code shall be continuous from fixture to fixture or other outlet.

G. Home runs and circuit wiring shall be as follows:

Length	Home Run Wire Size	Circuit Wire Size
120 Volts		
0' to 60'	12	12
60' to 100'	10	12
over 100'	8	12
277 Volts		
0' to 130'	12	12
130' to 200'	10	12
over 200'	8	12

H. Two wire branch circuit wiring within framed walls to switches or to receptacles may be connected using MC cable, where permitted by code.

I. Drops from metal conduits/junction boxes to individual lighting fixtures may be done using MC cable, where permitted by code.

3.06 SPLICES AND TERMINATIONS

- A. Splices in conductors #18 thru #10 AWG shall be zinc-coated, screw-on spring pressure type connectors with vinyl insulating jackets. Connectors shall be 3M Scotchlok or equal.
- B. Splices in conductors #8 AWG and larger shall be by means of long barrel indent type, Burndy Type YS of equal, with insulative tape covering.
- C. Terminations for conductors #9 AWG and smaller shall be by means of compression type lugs with molded nylon insulating jackets. Lugs shall be 3M Scotchlok or equal.
- D. Terminations for conductors #6 AWG and larger shall be by means of a single-hole tongue, long barrel, compression type termination which requires an indenter type connection on barrel using as type Burndy 'MY HYTOOL' hand operated tool. Lugs shall be Burndy type YA or equal.
- E. Miscellaneous hardware for electrical connections, such as nuts and washers shall be zinc or silicone bronze. Ferrous hardware shall not be used.
- F. Vinyl electrical tape shall be used whenever added insulation is required. Rubber and friction tape shall not be used.

3.07 MOTORS, EQUIPMENT, CONTROLS AND CONTROL WIRING

- A. Motors, air handling units, compressors, etc., and built-in control devices will be provided under other Sections of the Specifications unless noted otherwise.
- B. Provide control connections for devices and equipment noted on the Drawings.
- C. Provide power connections for equipment furnished under other Sections of the Specifications.
- D. The installation, connections and operation of controls not noted on the Drawings will be done under other Sections of the Specifications, including the furnishing and installing of conduits, wiring, outlet boxes, control components and connections.
- E. Control wiring shall be in accordance with the drawings and/or manufacturer's certified and approved wiring diagrams.
- F. Control wires shall be marked with "E-Z" tape markers at terminal points. Terminal blocks shall be marked to correspond to wire terminated.
- G. Provide conduit and wires, install and connect control equipment (starters, thermostats, push buttons, etc.) and connect motors, air handling units, air conditioning equipment, and built-in control devices, in accordance with wiring diagrams furnished under other Sections of the Specifications, complete and operative.

3.08 BALANCE AND PHASE ARRANGEMENT

- A. Electrical Contractor shall be responsible for the correct rotation of motor equipment to which he makes final connections.
- B. Phase positions "A", "B", "C", shall be either left to right or top to bottom at substation, panelboards, safety switches, motor starters, separately mounted circuit breakers, etc.
- C. Obtain a reasonable balance of load current between phase wires throughout the electrical distribution system. Use an accurately calibrated ammeter and record at full load the amperage at main buses and entrance cables of distribution equipment, such as panelboards, feeder breakers, etc. The maximum unbalance should not exceed 10%.
- D. During the guarantee period, if evidence indicates balancing is unfavorable make such adjustments as are required to correctly balance the electrical distribution system at no additional cost to the Owner.

3.09 FIRE SPREAD PREVENTION

- A. Where conduit, wire or cables pass through openings in floors or fire rated walls, the opening shall be fire stopped so that the possible spread of fire or products of combustion will not be substantially increased.
- B. Fire stop fittings and blank plugs shall be O.Z./Gedney "Fire Seal" having a fire rating equal to or greater than the rating of the floor or wall penetrated.
- C. Conduits passing through floors or fire-rated partitions, unless cast-in-place in the construction, shall pass through cast openings, sleeves or core-drilled holes.
- D. Where the annular space between the conduit and opening or sleeve does not exceed 1/2 inch, the opening shall be filled with firmly packed mineral wool.
- E. Where the annular openings exceed 1/2 inch, fire-stop fittings, as specified above, shall be employed.
- F. Where sleeves or round openings are provided for future installations, they shall be sealed by means of blank plugs of type specified above.
- G. Openings around wires or cables which penetrate floors or fire rated walls shall be sealed employing "fire-stop" fittings installed in cast openings, sleeves or core-drilled holes, properly sized to accommodate the fittings.

3.10 IDENTIFICATION OF EQUIPMENT

- A. Motor starting and control switches, disconnects, starters, cabinets and panelboards shall be provided with engraved (black background with white letters) phenolic nameplates, The designation of the nameplate shall clearly spell out the function and location of equipment controlled. The nameplate shall be permanently attached to the unit.

- B. Junction boxes and pull boxes except those directly located at fixture or equipment to which system is connected shall be identified with marker in large legible lettering to indicate system and circuiting on which installed.
- C. Panels shall be provided with a typed directory listing circuits and associated breaker numbers.

3.11 ACCESS PANELS

- A. In general, junction boxes, pull boxes, disconnects, motor starters, duct detectors, flow switches, etc., shall be accessible through the removable panels in the ceiling. Where ceilings are not removable and in walls where access is required to junction boxes, pull boxes, etc., access panels shall be provided as part of the Work under this Division of the Specification. Access panels shall be suitable for finish of wall or ceiling and shall be submitted for the Architect's review.
- B. Under this Section of the Specification, whenever possible, group junction boxes, pull boxes, etc., together to keep the required number of access panels to a minimum.

END OF SECTION